

THE
QUARTERLY JOURNAL,

July, 1823.

ART. I. *An Account of the Eruption of Vesuvius, in
October, 1822.* By G. POULETT SCROPE, Esq.

[With a Plate.]

Naples, March 10, 1823.

SINCE the end of the last century the great crater of Vesuvius has been gradually filled by the accumulation both of lava boiling up from below, and of scorïæ falling from the explosions of the different minor mouths which were formed at intervals during the last twenty years on its bottom and sides. When I visited the mountain in 1818-19, this great crater was almost entirely obliterated;—no regular concavity appeared, but in its place a rough and rocky plain, rising into two rude eminences at the northern and southern extremities, covered with blocks of lava and scorïæ, and cut up by numerous fissures, from many of which clouds of vapours were evolved in considerable quantities. By the eruption of last October this state of things has been totally changed. The explosions which then, during the space of more than twenty days, were incessantly and with terrific violence taking place from the focus of the volcano, broke up and threw out all this accumulated mass, and ended by completely *gutting* the mountain, so as to leave an immense gulf or chasm of an irregular and somewhat elliptical shape, about three miles in circumference if measured along the very sinuous and irregular line of its extreme

margin, but somewhat less than three-quarters of a mile in its longest diameter; which is directed from N.E. to N.W. Its depth is perhaps rather above 700 feet, but decreases daily by the dilapidation of the sides.

The enormous quantity of matter which, previously to the eruption, occupied this space, was thrown out in fragments of every size, varying from blocks of some tons in weight, to the most impalpable powder. The greater part, however, certainly issued from the mountain in the latter form, having undergone a complete trituration during the process of continued and repeated ejection. After the first four days of the eruption, the substances thrown out were solely pulverulent, becoming finer, lighter, and of a lighter colour every day. These ashes as they are called, (certainly without much propriety, being only pulverized lava,) rose from the crater in dense and prodigious clouds, to a height, at one time, of nearly two miles, and were thence borne away on the winds to great distances, the heavier particles falling in showers from the line of clouds thus formed along its whole track. The vast crater, which was emptied by this violent process, presents an aspect very different from that which is usually assumed by the concavities of volcanic cones. These generally appear in the regular form of an inverted cone, whose sides slope at about the same angle to the horizon as those of the outer cone. This is, indeed, invariably the case with every cone which is produced by a single volcanic eruption. That of Vesuvius, however, resulting from the accumulated products of, perhaps, many hundred eruptions, must consist of numerous beds of scoriæ and fragmentary lava, alternating with the strata of lava rock, which at intervals have been poured in fiery torrents down its outer slope, and congealing there, have remained like so many massive ribs, to give strength and solidity to the structure. Through this succession of beds, then, has the present crater been forcibly hollowed out by the explosive energy of the volcano. It appears as a tremendous abyss of enormous proportions, surrounded by craggy precipices that rise almost vertically from the rude heaps of fallen fragments which form its

floor, and conceal the volcanic orifice. The extreme periphery of the crater in some parts juts over these precipices, so that on attaining its margin you look directly down into the gaping cavity. In others, a steep inclined plane, of no great width, intervenes between the edge of the cliffs and the acute ridge in which the interior and exterior slopes terminate. On this inner and shelving surface it is necessary on many points to pass while making the tour of the crater; in general, it affords a firm and safe footing, being formed of the fine sand which was the last product of the late eruption, and into which the foot sinks to some depth; but, when the surface of this slope is hardened by frost into an unyielding and slippery crust, (which was the case on the morning of my first visit,) the passage is extremely perilous. The danger is, in fact, the same on the outer as the inner slope, since a slide or a false step would be probably fatal on either side; but the idea of falling into the crater is more appalling than that of rolling down the exterior of the cone.

The cliffs that encircle the great cavity by no means follow any regularity of curve, but project or recede in salient and retiring angles. Their abrupt faces which are rocky, jagged, and unpicturesque in the extreme, present sections of many currents of lava, some of which are of great thickness and extent, lying one above the other in a direction more or less approaching to the horizontal. Most of them offer a *columnar division* of the most marked and decisive kind. Some are almost as regularly prismatic as any ranges of the older basalts. In some the spheroidal concretionary structure on a large scale is equally conspicuous. Between the currents of lava are interposed shapeless beds of volcanic conglomerate, consisting of fragments of all sizes heaped together in chaotic confusion. These, as well as the beds of lava, are occasionally intersected by vertical or nearly vertical dikes, similar to those of Somma above the *Atrio di Cavallo*.

The whole scene presents, perhaps, an unparalleled example of the horribly sublime. The deep and yawning gulf, on the verge of which the spectator must hang to observe its terrors;

the rugged and fractured cliffs that frown around it; their gloomy colouring, and calcined aspect; the dense sulphureous vapours that rise from fissures on every side; together with the thundering echoes which almost at every minute proclaim the fall of some fragments detached from the sides into the abyss below; create a sense of grandeur and awe, too impressive to be easily effaced. The great crater of *Ætna*, even if larger, which I much doubt, is in my opinion by no means so striking. Time and the meteoric agents have considerably softened the features of this last scene, while there is a vivid and terrible freshness in the crater of *Vesuvius*; the wound which has been torn through the bowels of the mountain is as yet raw and unhealed; and the imagination forcibly recurs to that powerful demonstration of the energies of Nature in all their violence, which so lately was exhibited from this spot, and which is liable to re-commence at the instant.

Viewed from a distance, the crater still appears to emit at all times a considerable quantity of smoke, which increases prodigiously during stormy weather. However, on attaining the summit of the cone, it becomes evident that little or no vapour rises from the concealed vent of the volcanic focus at the bottom of the basin. Thick clouds, on the contrary, take their rise just within the margin of the crater, evolving themselves from fissures in the broken extremities of those currents of lava which were produced by the last eruption, and which without doubt are still at an extremely high temperature, probably, indeed, incandescent and liquid at their centre, since paper and wood take fire immediately on being thrust to a certain depth in their clefts. The slowness with which lava conducts caloric is well known. It is, therefore, to be expected, that the fall of rain in any quantity would proportionately increase the activity of these vapours, which are almost solely aqueous. The moisture deposited on the surface of the recent lava currents, that nearly envelop the whole cone, percolating to the interior, becomes converted into steam, and forces its way through the longitudinal rents or channels that occur in every lava current, and particularly

in those whose course has been rapid, until it issues at last in clouds from the ragged edges of the stratum at the margin of the great opening.

The great cone of Vesuvius has lost considerably in height. A very large excrescence on the south side, resulting from the accumulated ejections of three or four minor mouths, and forming its most elevated point, fell in during one of the most violent convulsions of the last eruption; so that the opposite or north side of the crater is now the highest peak of the cone. By barometrical measurement I find it to be 3829 feet above the sea. The lowest part of the ridge, forming the periphery of the crater, is on the east side above Pompeia, and 3346 feet in height. The absolute elevation of the mountain has been diminished by rather more than 100 feet, while the bulk of the cone has been greatly increased by the lava torrents that clothe its sides, as well as the still greater mass of ejected fragments.

Amongst the latter products are some few pieces of granite, and of crystalline limestone with mica, Vesuvian, &c., precisely similar to the erratic blocks which so frequently occur in the conglomerates of the Monte Somma; and hence it appears that the explosions of this recent eruption have shattered and blown into the air a portion of the strata belonging to that older volcano. But by far the greater number of ejected blocks, with which the slopes of the cone of Vesuvius have been strewn by the late eruption, consist of leucitic lava, and are evidently fragments forcibly torn off from those currents of an earlier date, whose sections are seen in the broken and precipitous cliffs of the crater. Many of these lavas have a highly torrefied aspect. They have obviously undergone a *recoction*, if the expression is allowable, either from having been exposed for ages to the heat, which, in the centre of the cone, from whence they were probably torn, must have been always intense, or during the period of rejection by the present eruption, having perhaps more than once been vomited forth and thrown back again into the burning gulf, before their final landing on the exterior of the cone. These fragments exhibit

a more or less pearly lustre, apparently in proportion to the greater or less degree of torrefaction they have endured. The fusion of the leucites seems to be the cause of this appearance. In some specimens this process has been carried to such extremity that a portion of the lava has run into a black glass, which fairly merits the name of *Leucitic Obsidian*. In colour, fracture, and transparency, this substance resembles the common trachytic obsidian of Lipari, but differs from it in melting before the blowpipe into a black glass, while the obsidian of Lipari is well known to produce one of a greyish-white colour.

But this is not the only alteration produced on these erratic blocks of lava, by their re-exposure to the intense action of the volcanic furnace. In some cellular specimens, the cavities are thickly lined with crystals of specular iron, and of various other minerals, hitherto undescribed, if not unknown. Amongst these, the most remarkable are delicate capillary crystals, which are found by the lens to be hexagonal prisms, hollow within, formed by the lateral junction of six long rectangular plates. They are either white, or of a light flesh-red colour, and occupy cavities which seem to have been produced by the total or partial disappearance of the larger crystals of *leucite*. Acicular radiated mesotype occurs in the same manner; as well as brilliant crystals in rhomboidal dodecahedrons, of a dark-green colour. These new crystalline minerals, thus, to all appearance, created out of the elements of a lava composed simply of leucite and augite, during its re-exposure, under peculiar circumstances, to the action of volcanic heat, may be expected to throw a useful light on the origin of the numerous and problematic minerals occurring in those erratic blocks of crystalline limestone, &c. &c., of the Monte Somma, which appear to have undergone a similar process during the activity of that ancient and enormous volcano; and a stronger degree of probability is thus added to the opinion, by which these blocks of limestone, with their accompanying mica, augite, garnet, vesuvian, nepheline, &c. &c., are supposed to be, not unaltered fragments of primitive rocks, but portions, perhaps, of the cal-

careous or other strata which once covered the site of Vesuvius, variously affected by repeated and continued exposure to the influence of the mysterious and ever-varying phenomena which take place in the fiery depths of the volcanic laboratory.

In a chemical light, the eruption of last October distinguished itself from all preceding ones by the excessive abundance of sulphur deposited by the vapours evolved from the lava it produced. The various chemical products of these fumarole have been collected and analyzed, with great care, by Messrs. Monticelli and Covelli, who have been closely occupied, since the date of the eruption, in preparing for the press a descriptive work on the subject, which will probably be out in a few weeks, and, I have no doubt, will prove extremely interesting. If I can discover any method of forwarding it to England, I will despatch it as soon as published. In the mean time, perhaps, these brief remarks may help to gratify the curiosity of the readers of this Journal.

Perhaps, it is worth while to mention, that the appearance of the actual crater of Vesuvius offers a complete confirmation of the opinion I was led to adopt in France, as to the identity of the circus or upper basin of the Dordogne, in the Mont D'or, with the principal crater of that extinct volcano.

Were the fires of Vesuvius to be in turn extinguished, and its activity cease from this moment, (a circumstance by no means *impossible*,) a few centuries would probably see the interior of the crater laid open by a valley, through which the waters accumulating at its bottom, would discharge themselves into the sea; and in this event, the resemblance to the upper circus of the valley of the Dordogne, would be most strikingly exact. The lofty and precipitous rocks encircling each basin offer the same general characters; equally ragged, shattered, and calcined, they are composed alike of conglomerate beds, alternating with strata of lava, prismatic or not, and intersected occasionally by vertical dikes. From the margin of these cliffs, in either case, the outer flanks of the cone shelve down-

wards, with a steep and regular slope, to the base of the mountain.

Another interesting parallel may also be drawn between the large accumulations of volcanic sand (or ashes) and fragmentary lava, (commonly called lapillo,) washed down from the sides of Vesuvius by the rains, which fell with great violence during the late eruption, and those large deposits of tufaceous conglomerates, in the volcanic country of France, to which I assigned, upon the spot, a similar origin. Nothing could be more confirmatory of the justness of that hypothesis, or more clearly illustrate the mode of formation of such rocks, than the phenomena which took place on all sides of Vesuvius, a few days after the great crisis of the eruption in October last. The fine impalpable sand thrown out from the crater for many days together, had covered the surface of the mountain to the depth of from one to five feet; and necessarily impeded whatever rain fell upon this space, from draining off, as usual, through the porous and loose matters which compose the sides of the volcano. In this state of things, on the 27th October, the clouds, which had long gathered in dense masses round and above the cone, began to discharge their contents in prodigious quantities; and, in consequence, torrents of sand, mixed with water, appearing like liquid mud, swept, with terrible impetuosity, down the slopes, tearing them up in their passage, hurrying along fragments and blocks of lava, of great size, (some even from 40 to 50 feet in girth,) and depositing heaps of alluvium on the sides and at the foot of the mountain. The damage occasioned by these "*lave d'acqua*," or "*di fango*," as they are called in the language of the country, was far greater than what was suffered from the "*lave di fuoco*." The latter only destroyed a few acres of wood and vineyard, but by the former a much larger space of cultivated soil was devastated, walls were overthrown, houses and streets filled with sand and stones, and some lives even lost, from the suddenness of their descent.

There can be no doubt, that a great portion of the tufa

strata, under which Pompeia and Herculaneum lie buried, were deposited by alluvial torrents of this nature; and I make no question, but that parallel phenomena, on a larger scale, produced those massive formations of tufas and breccias, which shew themselves in such abundance around and upon the extinct colossal volcanoes of central France.

P.S.—I open my letter to say, that accounts have just arrived from Sicily, of an earthquake having done great damage in that island. Palermo has been shaken dreadfully, about thirty lives lost, and houses injured to an extent of loss equal to half a million sterling, it is said. Messina and Catania have suffered much less. It is difficult to say whether this calamity has any connexion with the eruption of Vesuvius last year, or with the dreadfully stormy weather we have had since. It is a very unusual phenomenon at Palermo.

References to Plate.

(A) Lowest lip of the crater immediately above Bosco Ire Case, and facing Pompeia. In this direction the side of the cone was split open during the eruption, and a large crevice formed, which threw up lava, scorïæ, and sand, on five or six points.

(B) Punta del Palo, the highest peak of the actual cone, and fronting the North.

ART. II.—*On Mineral Veins.* By J. MAC CULLOCH, M.D., F.R.S. Communicated by the Author.

IN a practical view, there is not a subject in the whole range of geology of greater importance, than that which relates to the history of mineral veins; and, accordingly, there are few that have been more examined. Neither is it by practical miners alone that this subject has been investigated; since theoretical geologists have not only compared, and reasoned on, the facts which these persons have brought to light, but have themselves, on many occasions, undertaken the labour of personal examination. It is, nevertheless, true, that, excepting in a very few particular cases, confined to narrow districts, which have been the subjects of great experience, no general rules have been established, from which any useful practical results have been deduced, or which are capable of laying the foundation of a rational theory respecting their formation and origin. We can neither conjecture, *à priori*, in what districts or in what rocks

they are to be expected, what courses they hold, what various forms and accidents they may display, nor what substances they contain. Where little information can be procured, much will not be expected.

Although mineral veins may exist without necessarily containing metallic substances; yet, as the general characters of these are the same, they do not require to be distinguished here, farther than as may relate to the nature of their contents. Minerals of many kinds are also occasionally found in repositories which cannot properly be called veins, and metallic substances are not even limited to these. To describe these latter cases first, will be to clear the present inquiry of circumstances which would otherwise encumber it.

Many metallic minerals are found scattered among the constituents of the compound rocks, so as almost to form parts of their composition. Thus, oxydulous iron is found in granite, gneiss, sandstone, and trap; molybdena in gneiss; and iron pyrites in slate, shale, and limestone. They sometimes, also, occur independently; neither forming part of the composition of rocks, nor included in distinct repositories. In this way, pyrites is found in innumerable situations; copper in the trap rocks; and oxydulous iron in the products of volcanic fire. Lastly, some of these are found accumulated in such quantities in particular spots, still without forming veins, as to admit of being wrought for economical purposes. Cobalt thus occurs in sandstone, as does copper. Iron, in the form of ironstone and bog-ore, is known to abound in beds; the first among the coal strata, and the latter in alluvial soils. Thus, also, tin and gold are found among alluvial soils; but, in these cases, the origin of the metals is, without difficulty, inferred to be in distant veins. It is likewise understood, that manganese occurs in the form of beds; as has also been said to happen with respect to mercury, copper, lead, and silver; but it is necessary to remember, that veins, holding a course parallel to the including strata, have sometimes been mistaken for beds.

Such parallel veins are, however, sometimes distinguished by the term of *flat*, while the intersecting ones are called *rake*

veins: but, as no useful information is communicated by the adoption of provincial and technical terms, they are here avoided. Geology can gain nothing by being further encumbered with terms that only produce an unnecessary jargon; and it is the duty of every one to avoid sullyng the English tongue. To shroud in the mystic terms of any science or art, whether in the phraseology of miners or the symbols of algebra, that which can be expressed in ordinary language, is either the result of a worthless ambition, or a proof of the superiority of the memory to the understanding.

Of the Forms, Positions, and Relations of Mineral Veins.

Mineral veins, like rock veins, intersect the strata at all angles, and are also occasionally parallel to them, throughout more or less of their courses. They imply a discontinuity of the rocks through which they pass, and are, in fact, composed of matter which has entered into the fissures that have been formed by the causes which influence the positions of strata. Hence, it is easy to understand how they are accompanied by those dislocations of the including strata, the varieties of which are numerous; although a fissure does not necessarily imply a dislocation.

As veins may hold any direction with regard to the including strata, so they may be placed in any position towards the horizon. But from a mere comparison of chances, it is plain that they must be far more frequently inclined than vertical; whence miners learn to distinguish between the upper and under sides of a vein. It is observed, that when mineral veins occur in considerable numbers in any tract of country, they maintain a sort of general parallelism; as if all the fissures to which they owe their origin had been formed, at the same time, by some common cause, or had been produced by the successive repetition of similar actions. This, also, it is remarkable, is sometimes the case where more than one set of veins exists, and where the posteriority of the one is proved by their invariably intersecting the other. This fact is remarkable in Cornwall, where the more ancient veins are directed, in a general

sense, from east to west, and the more recent from north to south.

Their longitudinal extent must evidently be limited, but it is often considerable. They have been traced for two, and even three, miles, in Cornwall; and it is said that one vein, in South America, has been ascertained to extend for 80 miles.

It is easy to see, however, that in a case of this nature, the union of some tendency to system, with a little inaccuracy, may easily confound many veins together. Observations made in such a spirit of extravagant generalization, must necessarily excite distrust, when we advert to the comparative length and breadth of such a supposed continuous fissure, and to all the circumstances under which these must have been formed.

The breadth of veins is extremely uncertain, varying from less than an inch to many yards. The question of their depth is more interesting, as it is believed by some to be indefinite: it is at least said, that their depths have never been reached by miners. If that were even true, it would not prove the truth of an opinion so improbable, when we consider the circumstances under which fissures must have been formed. When the separated or dislocated strata preserve an accurate parallelism, the same relative disposition must exist between the opposite sides of the vein; and we may thus, if we please, imagine it interminable. But if the including strata have lost their parallelism after separation, it is evident that, under one modification of this, they may, or rather must, come into contact in some part of the series, and that the vein will therefore disappear. This reasoning only takes a simple view of the consequences resulting from the appearances; but if the hypothesis of some geologists should be admitted, which supposes that the materials of veins were ejected from the depths of the earth, then indeed they may be indefinite in their downward progress. But this is pure speculation.

The absolute antiquity of veins, in any situation, is a subject respecting which no conjectures can be formed; but there are two modes of judging of their ages, within certain limits. It is evident, in the first place, that they are all posterior to the in-

duration of the strata, as they always imply fracture of these. If, again, it shall be proved that any veins are found in the primary strata, which do not also exist in the secondary, it will follow that they are of a more early origin than the deposition of the latter. It may be imagined, for example, that the veins of Cornwall are of a prior date to the formation of the English secondary rocks, because they do not occur in the secondary districts. Yet there is no proof of this; unless it could be shewn that secondary strata existed unbroken above these veins, or until tin or copper veins shall be found in the primary rocks, after removing the secondary, in the districts in which these exist.

That there are veins of different ages, is, however, rendered certain where two exist, and where, as often happens, the one intersects the other. This circumstance is not uncommon on an extensive scale. In Cornwall, a large proportion, probably all, of the easterly veins, are intersected by the northerly; and it is remarked, that the former are metalliferous, and the latter wanting in metals.

These intersections are attended by circumstances as interesting to geology, as they are important in the art of mining; in which they are often the source of much labour and expense, and even of ruin. As the first class of veins are frequently attended by dislocations of the strata, the same accidents attend the second; and, in the latest motions of the including rocks, it evidently follows that the first order of veins is included. Thus, in technical language, the effect of a second vein is to produce a shift in the first, often attended by circumstances, in the state and nature of its contents, which will be examined hereafter.

The extent of such dislocations in veins is variable; as may easily be understood from the remarks formerly made on the motions of the disrupted strata, in which they, necessarily, partake. Their direction is an object of the highest interest to the miner; as it is only by being able to form some previous judgment respecting it, that he is taught where to seek for the interrupted continuation of that which he has lost. Experience,

in different countries, often forms a tolerable, though not an infallible, guide for these; as must be very evident from considering the irregular displacements of strata: but such rules are still less capable of being extended to other countries, or to remote places. To determine whether the motion of one part of an inclined vein is to be termed an elevation or a depression, it is necessary to take the point of departure from the surface, as in the case of dislocated strata. When a vertical vein is shifted, it is evident that the adjacent rocks must all have been moved by the same quantity in a horizontal direction; an event, as formerly remarked, not favourable to the theory which supposes the fractures of strata to be the effect of subsidence.

The last circumstance which relates to the forms of veins, is their ramification. They are occasionally separated, and again reunited; certain technical terms being, in mining countries, applied to the intermediate mass. In other cases, they send out slender ramifications; and sometimes they are found to ramify, at once, into many small branches.

I have thought fit to separate from that which is matter of justifiable inference respecting the ages of veins, what can only be considered as an hypothesis, and which is, further, neither an intelligible nor an useful one. It has been said, that there are epochas to be traced in metallic veins, or that the metals are of different ages. Thus, for example, it is said that tin is among the oldest metals, because it is found in granite, and that lead is among the newest, because it occurs in the secondary limestone. I need not enumerate all the particulars contained in assertions so unfounded; while a few simple facts are sufficient to annihilate the whole system.

Cobalt occurs in granite, in many of the primary schists, and in the secondary sandstones. Copper has been found throughout the whole system, from granite up to trap inclusive. Lead is found alike in the primary and secondary strata, and iron is universal. I need not extend a list of exceptions that overwhelm the rule. If, again, the nature, or imagined age, of the rock which is traversed by a vein, is to be made the criterion of the age of the latter, or of the included minerals, it must be

remembered, that a vein must traverse every rock that was in existence at the time of its formation. The vein that intersects the granite, intersects the superincumbent strata also; and tin, copper, or lead, as it may happen, will occur in every part of it. It may have required uncounted centuries to form all the strata, but the vein is, comparatively, the work of a moment. It is a separate question, to what extent the adjacent including strata modify the contents of their veins; and it is one that will be examined hereafter.

Lastly, to attempt to classify metallic veins according to the nature of their contents, is to make arrangements worthy only of the cabinet mineralogist; systems which philosophy disclaims. If there were an hundred, for example, instead of ten or sixteen *lead-glance formations*, we must be content to remain ignorant of the ages of all that we cannot prove by the incontrovertible marks already indicated.

There is not one circumstance, in the history of veins, whether we regard their forms, positions, seats, origins, or the nature and disposition of the minerals which they contain, which can entitle us to conclude that they possess a resemblance or analogy throughout the world; that they are of definite and definable ages; or that they are, in any sense of the word, general or universal. Yet this doctrine is supported by geologists, who imagine that the mines of New Spain are similar to those of Hungary and Saxony. That Patrin, who had imagined the earth organized and endowed with a vital principle, should protract a zone of copper, silver, and lead, from England through Europe, Asia, and America, may be excused. But it is an abuse of the term generalization, to extend it alike to the visions of theorists and the inductions of philosophers.

Of the Seats and of the Contents of Mineral Veins.

The nature of the rocks in which mineral veins are found, is in every respect an interesting object of inquiry; but it is necessarily very limited, and, what is worse, cannot be converted to any useful purposes. They may be said rather to belong to countries than to rocks; since, in one, that substance may be

highly productive of veins and metals, which, in another, is deficient and barren. That they are most abundant in the primary or ancient rocks, is, however, certain. They are also more common in the stratified substances, namely, in gneiss, micaceous schist, and argillaceous schist, than in granite, or in the older porphyries. In the secondary or recent strata, they occur chiefly in the lowest, as in that which has been called in England the mountain limestone, and are scarcely found in the upper strata, or above coal. In the same manner, they are rare in the later trap rocks: but, if Hacquet's observations are correct, they occur at Nagyag, either in these, or, as he thinks, in ancient volcanic rocks.

In the primary rocks, they are sometimes found at the junctions of granite with the strata, as happens in Cornwall and at Strontian. But it is fruitless to attempt to derive any practical advantages from any thing yet known on this subject; unless as the experience acquired in particular districts may be a guide for these. The limitation of tin to Cornwall and a few other spots, and its exclusion from countries formed of the same materials,—the barrenness of gneiss in Scotland, compared with its fertility in Saxony, may be added to a thousand other instances, to prove that we must be content to possess mines wherever they are found, without wasting our hopes and our means in vain endeavours after them, where we have no evidence of their existence. That much false philosophy should have been adopted on the subject of mines, is a natural consequence of that perversion of judgment which so often attends the pursuit of wealth, and of that subversion of the reasoning powers which is produced by examples of its sudden acquisition.

The contents of mineral veins are various; and although the metallic substances form the most valuable part of them, they bear a very small proportion to the rest. No general rules respecting these contents can be given, as they vary in almost every country, in every vein, and, often, in every part of a vein. It is common, however, to find that the sides next to the including rocks are formed of earthy matters of very ordinary

aspect. In some cases, this substance is clay; in others, quartz is found; and, not unfrequently, it consists of a conglomerate formed out of fragments of the bounding rocks, united by various crystalline and earthy substances. It is common, in these cases, to find that the including rock is more or less decomposed and altered, at its junction with the vein. It has also been observed, that large detached fragments of the neighbouring rock are sometimes included within the body of the vein. In some cases, this occurrence presents an interesting variation; as, when a vein traversing schist and granite together, is found to contain fragments of the former within the space bounded by the latter, and the reverse. This fact serves to prove the extent of the revolutions, of a mechanical nature, which must have taken place in the vein; either at the time, or after the period, of its formation.

It is unnecessary to enumerate all the earthy minerals which have been found in veins; but the most common are quartz calcareous spar, barytes, and fluor. These, like the metallic substances, are found in different parts of the vein, and are crystallized in different forms, wherever cavities are present. The metallic minerals are found variously disposed; sometimes lining similar cavities in their crystalline forms; at others, collected into lumps, or deposits, in different parts of the vein; and at others, again, more generally diffused among the general mass of materials. In some instances, only one metal is found in a vein, in others, two or more; and these are sometimes distinctly separated, at others intimately mixed, so as to be a source of much trouble to the miner. It is occasionally found that the minerals, whether metallic or earthy, are arranged in layers parallel to the sides of the vein; and, in some of these instances, there is, further, a perfect correspondence on the opposite sides. Such, also, is the capricious disposition of the metals, that they sometimes disappear altogether, after having abounded through a large space; so that it becomes necessary to abandon a mine that had once proved very profitable. It is owing to these perpetual variations in the contents of mineral veins, that the characters of particular mines

are subject to such important alterations, and that chance, in the ordinary acceptance of the term, baffles all the calculations of the proprietor. Yet rules are still to be found in every mining country. These, too, are, unquestionably, of occasional value in practice; but they are always local, and if they may sometimes serve valuable purposes in practice, they offer no facts on which a philosophical geologist can possibly reason.

The intersections of veins are sometimes observed to produce variations in the nature and disposition of their metallic contents; but these, like most other rules, are of a local nature. It is also said that masses of ore are found at the intersections of more recent veins, and that intersecting veins of different periods, necessarily differ in the nature of the metals which they afford. It is asserted, further, that in Cornwall, "if two metalliferous veins cross from opposite sides of the line perpendicular to their intersection, they become less productive at and after the junction; but that, if they cross from the same side of it, the reverse effect takes place." It is further there remarked, that, "after the intersection of a more recent vein, the metallic produce of the ancient vein disappears." If any remarks of this nature have a value, it is not very intelligible. The same proposition is both true and false at the same time; since it is evident, that where the miner may have chanced to work in an opposite direction, the very reverse effect must take place. Like too many other conclusions of a similar nature, their chief value consists in warning us not to rely on observations made at hazard, and guided by no principles.

There is one circumstance, however, respecting the variation of the contents of metalliferous veins, which is of importance towards a rational theory of them; if, indeed, it should prove to be really founded on facts sufficiently extensive.

It is said to be a general remark, that, in all countries where veins traverse strata of different natures, their metallic contents vary with some relation to these; and that, in the same vein, the vicinity of some strata renders the vein more productive than that of others. But the facts adduced to prove the truth of this observation are neither very numerous nor very definite.

it remains to be seen, by a further extension of rational and unbiassed investigations, whether they are not swallowed up by a mass of exceptions. It is said, for example, that in a vein near Callington in Cornwall, passing through schist and granite, the copper which it contains is found in the former, and the tin in the latter, part. It is further said, that in Cornwall, similar veins are poor in the schist, and rich in the granite. It is also asserted, that veins are most productive at the junction of the schist and granite, not only in Cornwall, but in Silesia and elsewhere. There is not one example of this nature, to which there are not exceptions many times exceeding them, for which the reports of the same observers may be consulted. It would be endless to quote instances; as it would be fruitless here to record all the observations that have been made on these subjects; since the conclusion would be, to draw, as might equally be done without them, no conclusions. Whether, on the subject of the influence which strata have over the contents of veins, any exception ought to be made in favour of Derbyshire, where this is said to occur, it seems fruitless to ask; until miners shall fairly enter on the field of accurate observation, or geologists, discarding their prejudices, shall seriously turn their attention to a branch of the science which is, most particularly, its opprobrium.

Of the Theory of Mineral Veins.

On such a foundation, it has been attempted to build theories of mineral veins; and, as is usual in similar cases, the opposing opinions have been maintained with a vehemence proportioned to the want of evidence on both sides. It is necessary to state these two hypotheses, before inquiring into the circumstances by which either of them may be countenanced or opposed; and it is scarcely necessary to say, that the only important question at issue, concerns the manner in which the contents of the veins were formed and introduced; as the fissures in which these are contained have formerly come under review.

It is said, on one hand, that all the materials of veins have been deposited from the same universal solution whence the

rocks were, on the same hypothesis, formed. But there are two modifications, at least of this aqueous theory. While the rocks were in the act of being precipitated from the universal solvent, the veins were undergoing the same process; and hence they are esteemed to be of different ages, corresponding to those of the strata or rocks in which they lie. How such an operation could be effected is not explained; and it is fruitless to inquire, where, in lieu of ideas, we have only unmeaning words. Time may be better employed than in labouring to account for what is impossible. In the other modification, the fissures were formed in the rocks yet soft or yielding, by drying and contraction; and the metallic or other minerals, remaining in the solution after the precipitation of the rocky materials, were then precipitated in these fissures.

On the other hand, it is maintained, that the same power of subterranean expansion which produced the fracture and dislocation of the strata, introduced the materials into the veins, and that they have crystallized from a state of fusion, not of solution in water. Neither of these theories will require a very long examination; but the arguments that relate to both are, in some cases, involved together.

With respect to the aqueous hypothesis, it involves the same fundamental objection made to the precipitation of rocks from solution in water: it is at variance with the laws of chemistry. That objection would still be a fatal one, though the hypothesis should be limited to the filling of veins alone, though it were conceded that the rocks had been produced in some other manner, and though the production of veins was admitted to be posterior to the consolidation of the strata in which they lie. Even if the power of this imaginary universal solvent were granted, the difficulties are still insuperable; unless it could be proved why the metallic or other minerals of veins were not deposited every where alike; why, like those which form rocks, they were not deposited in strata; and why they were not only directed exclusively to fissures, and to a few of these in distant and select places, but limited even to partial spots in the same vein.

These are the leading objections to the general hypothesis, and they are unanswerable. The few real arguments from facts which have been adduced in support of it, are of small value, and will require very little discussion.

If it be conceded, as is the fact, that many of the substances found in veins are the produce of watery solution, there are many others which, as far as we yet know, cannot be produced in this manner. Not to enumerate all these, it is sufficient to notice in general, the greater number of the metallic minerals. It has been argued, that the minerals of veins are deposited in layers parallel to their sides, precisely as ought to have happened on this hypothesis. To this it is easily answered, that the fact is not so, except occasionally; as they are frequently congregated in irregular lumps, or dispersed among the other materials, or wanting for considerable spaces, or found lining the insides of cavities. Neither of these occurrences ought to be found, according to the hypothesis; and, more particularly, there could be no cavities on such a system of deposition from above. In such a case, also, the layers of minerals ought rather to be parallel to the horizon than to the walls of the vein. The argument derived from the presence of rounded materials in veins is worthless, because the fact itself is extremely rare. It is an exception instead of a rule, and may be admitted without involving the whole hypothesis.

With respect now to the other theory, which presumes that the contents of mineral veins have been injected from below, as those of granite and trap veins have been, the difficulties are assuredly not less, if they are not even greater. The arguments for it rest partly on this very analogy; partly on real or imaginary chemical facts relating to the production of minerals by fusion; partly on some mechanical appearances; and partly on the principle of dilemma. If it be really a case of dilemma, the one horn appears as fatal as the other, and there can be no theory of mineral veins.

The argument from the analogy of trap and granite veins is exactly one of those superficial resemblances, consisting in words rather than things, which it is painful to find in the writ-

ings of such philosophers as those by whom it has been offered. It serves to shew how weak the best of us are, when we suffer our prejudices or our wishes to interfere with our powers of reasoning. It may be conceded, that the fissures have been produced by the same subterranean changes which have displaced the strata; yet this admission does not involve a concession to the rest of the hypothesis. It does not necessarily follow, that the mineral contents of these veins have been injected from beneath in a state of fusion, although the power of heat may have been the cause of the fissures themselves. The presence of fragments of the including rocks in the veins, which has also been used as an argument for this theory, is a fact of just the same value: it proves the forcible displacement and fracture of the strata, but nothing more.

As to the chemical arguments derived from the insolubility of many of the contents of mineral veins in water, and their production from fusion, it is easy to shew that many of them certainly are produced from solution; that many others may have been generated in this way without a breach of chemical laws; and that some of them could not have been consolidated from fusion. I shall reserve these particulars for a general view at the end of this paper, when the several minerals producible in either mode will be enumerated.

In the mean time, it is impossible to conceive how, if the contents of these veins had been injected in a state of fusion, the fragments so often found in them should have escaped this process. I will not here say, as has also been objected, that clay could not have been found in mineral veins on this principle; because it is easy to understand how the infiltration of water should have decomposed portions of the veins, in the same manner as rocks are converted into clay, though deeply situated beneath the surface.

Whatever objections may be made against the aqueous hypothesis, from the peculiar dispositions of the minerals in the veins, are at least equally valid against the igneous one. It is impossible to comprehend how these could have been produced from a state of igneous fluidity, any more than from a state of

solution. It has also been said by the supporters of this hypothesis, that the absence of the solvent water from the veins is a proof that their contents were not deposited from water. It assuredly does not prove that ; while, as it respects the igneous theory, it is merely an argument from dilemma, that proves nothing in its favour, if it be not truly a case of dilemma. In having recourse to this species of reasoning, the first step is to establish the necessity of the alternative.

Another imaginary chemical argument has been derived from the mutual impressions of co-existent crystals in the veins. This is a view founded on the nature of granite, and other rocks crystallized from fusion ; but it is an analogy which has been abused, no less in this case, than in that which relates to the nodules of the amygdaloids. The mutual impression of quartz, or of chalcedony, and calcareous spar, does occur in these, from successive infiltration and crystallization ; and, according to the order in which these substances are deposited, either may impress the other, as I have fully shewn in my work on the Western Isles. It is perfectly consistent with this to imagine, that any number of minerals admitted, at distinct intervals, into cavities, should present the same appearances ; and that, in modes much more complicated than could happen from any simultaneous crystallization from an uniform fluid of fusion. But, in truth, though the inconceivable chemical agencies required to separate all the minerals that are found in a compound rock, have been made almost a subject of ridicule against the supporters of aqueous theories of rocks, it would be difficult to imagine any process more difficult than that which should crystallize all the variety of earthy and metallic minerals that are sometimes found together in veins, from an uniform fluid of fusion. Chemists who will bestow a moment's consideration on this subject, will see without difficulty what it is unnecessary to detail here.

Some farther arguments, as much mechanical as chemical, have also been adduced in favour of the igneous hypothesis. It has been said, as an argument from dilemma, that, on the

aqueous theory, no close veins or deposits of minerals, surrounded on all sides by rock, could exist. But it is obvious that these are equally impossible, on the other view of a cause. Where there is no access for a watery solution, there is none for an igneous fluid. To make use here, as has been done, of a theory of igneous secretion, such as been applied to the nodules of trap, is to adopt a scheme which is perfectly gratuitous, and to reject one the existence of which is proved. If mineral veins have, in any case, been filled by a secretion from the including rocks, there can be no choice between a process which is actually proved to exist in nature, and one which, not only has not been observed, but which is supported by no chemical analogy.

It has also been said, that the solidity or fulness of mineral veins could only have happened from igneous injection; as the abstraction of the water after deposition, must have left cavities or vacuities of some kind. With no small want of reflection, it has also been said that cavities could only have been formed in them on the igneous hypothesis, from the disengagement of elastic fluids. These, it is plain, are conflicting statements; as, without a charge of captiousness, may be fairly urged. The fact, such as it is, is quite as explicable on the one hypothesis as on the other, and is alike worthless to both. The want of marks of gradual and regular deposition, is a negative argument, which, if it proves one hypothesis to be wrong, does not render the other right; and, with respect to the existence of fragments already mentioned, the state of these is assuredly calculated to prove any thing but that they have been supported and involved by an ignited fluid.

Such are the objections to an hypothesis, which, however it might be deemed a necessary part of the general theory to which it belongs; and, however we may respect the talents of its author and supporter, cannot command a moment's attention, unless it shall hereafter be most materially modified by new views and new discoveries. Thus modified, it must indeed disappear; but its downfall does not involve that of the theory

which considers granite and trap of igneous origin, and which maintains that the strata have been elevated by forces directed from below.

The pleasures of doubting have no charms to induce me to give this discussion so conspicuous a place as it here occupies. But facts are required by the reader; and, it is the duty of the author to see that they are not so managed by theorists as to mislead him; to place them so in array that he may form the conclusions which they seem to justify; even though these should leave the subject as they found it. The strength of assertion which has been brought into this question on opposite sides, leaves no choice in this case; and, if the discussion shall be said to prove nothing, it must be recollected that, to prove the existence of falsehood, is, in these cases, the first step towards truth.

Of the Minerals which are respectively produced from Solution, and from the Action of Fire.

It remains now, as was promised, to examine by our chemical and mineralogical experience, how far any of the substances found in mineral veins are the produce of crystallization from watery solutions, and in what cases they are crystallized from a state of igneous fluidity, or from sublimation. It is not intended to enter at large into this subject, because our information is still incomplete. A general view alone will be sufficient for the present purpose. The facts themselves, as they regard the two theories which have been examined, are singularly conflicting; although as far as they offer arguments for either, the balance is palpably in favour of an aqueous one. It is evident that these are the facts on which any future hypothesis must chiefly rest; whatever further considerations may be required for explaining the various circumstances of other natures which attend mineral veins.

In inquiring first respecting the earthy minerals, and in trying to determine the number of those which may be produced from watery solution, we are compelled to have recourse almost entirely to the chemistry of nature; as the limited solubility of

the earths prevents us from deriving much information from our own circumscribed and cramped experiments. For the sake of brevity, I have thought it expedient to throw them into the form of a list; and, to save repetitions of the proofs on which their aqueous origin rests, these may be here given in a preliminary form.

The formation of quartz, chalcedony, and calcareous spar, may almost be witnessed; and that of the latter in particular is so rapid, that it can be seen in calcareous caverns nearly as well as the crystallization of ordinary salts. This substance is generated both by infiltration, and in solutions of carbonat of lime. Chalcedony is produced in the former way, and quartz in both. In the work to which I have already referred, it was also shewn that those veins which consist of quartz or carbonat of lime, are generated in this manner.

In the remarks on the amygdaloidal structure, to be found in the same place, I have proved that the theory of infiltration explains the imbedded nodules of the rocks of this character, and that these have been produced in this manner. Thus there is established a considerable list of minerals formed by means of aqueous solution. That which takes place in this case may equally happen in a mineral vein.

Although we have not yet proved that all the other earthy saline minerals, as they are sometimes called, such as gypsum, barytes, &c., are produced from watery solution, chemistry and analogy both render it very probable; and these may therefore be added to the aqueous list with little hazard of error; certainly with much less than they could be referred to an igneous origin. Lastly, we may pretty safely also refer to the same division, those which are found associated or imbedded in quartz, as disthene is.

The list, constructed from these various kinds of evidence, will therefore contain the following minerals, and possibly many more; and, it is here divided under these several heads of more or less unexceptionable proof. I do not add those which are imbedded in primary limestone, because it is possible, or more than possible, that some of these have undergone

the process of fusion ; in which case their imbedded minerals must be referred, as those of granite are, to an igneous origin.

SALINE MINERALS.

Carbonat of lime.	Carbonat of barytes.
Fluat of lime.	Sulphat of barytes.
Gypsum.	Carbonat of strontian.
Brownspar.	Sulphat of strontian.
Arragonite.	Boracite.
Wavellite.	

With respect to some of these, it will be perceived that the proofs are complete, as they are found in the following division :

MINERALS OF THE AMYGDALOIDS.

Quartz ; including amethyst.	Mesotype.
Chalcedony, in all its varieties.	Nadelstein.
Opal.	Leucite.
Sulphat of barytes.	Sulphat of strontian.
Fluor spar.	
Olivin.	Prehnite.
Epidote.	Laumonite.
Mica.	Ichthy ophthalmite.
Chlorite.	Harmotome.
Steatite.	Analcime.
Lithomarge.	Stilbite.
Chlorophæite.	Chabasite.
Conilite.	Arragonite.
Brown spar.	

To which may be added, as found sometimes in aqueous quartz,

Disthene.	Tremolite.
Epidote.	Tourmalin.
	Actinolite.

And as found in calcareous spar,
Emerald.

I have here limited the list of aqueous minerals strictly to those which are supported by the proofs above-mentioned ; but, if those also had been enumerated which are found associated together in cavities of veins, where one or more of the number consists of minerals decidedly aqueous, it might have been considerably extended. The mineralogical reader who is thus furnished with the principles on which this catalogue has

been constructed, may easily pursue further what it is here unnecessary to detail more minutely.

In examining now the metallic minerals, so as to determine which of them may have been formed from aqueous solutions, we may first have recourse, partly to direct experiments in our laboratories, and partly to analogies drawn from these. The ready means which chemistry affords for producing many of these substances, render these artificial proofs, if they may be so called, much more complete than in the case of the earthy minerals.

The other kind of proof which may be considered natural is, as in the former case, drawn from their association with those earthy minerals which are already proved to be of aqueous origin. That association is in some cases very accurate, because the metallic is imbedded in the earthy mineral; and thus the proof from nature is complete. It is twofold, however; the metallic mineral being either crystallized within an earthy crystallized one, as rutile is in quartz, or else disposed in strata of aqueous origin, such as shale and secondary limestone, that have not undergone the action of fire.

The natural proofs are not quite incontrovertible, when the metallic minerals are merely associated in the cavities of veins with those earthy ones which are of aqueous origin. Yet they are, perhaps, sufficiently strong; particularly when it is seen that many of these are, in reality, substances which, in other cases, carry much more decided proofs with them, either from other natural associations, or from chemical experiments and analogies. As the present remarks are not offered as including a series of positive facts on which a theory is to be erected, but merely as hints towards one, or as indicating the road that ought to be followed in attempting to explain the origin of mineral veins, any inaccuracies or doubtful particulars can be of no moment. The observations will answer all that is intended, if they turn the attention of mineralogists to a subject which ought to have been examined by those who have proposed or adopted theories of this nature; and who, in this case, seem to have proceeded by inverting the rules of phi-

losophy. It will hereafter be seen that some minerals, both earthy and metallic, have a double origin, or are formed both from fusion and solution; so that perhaps in some of the cases here enumerated, some of these, such for example as those which are concluded to be aqueous from their association with carbonat of lime, may possibly be exclusively of igneous origin.

In examining the chemical evidence, it will be convenient to class the metallic minerals according to their leading relations of this nature, as it is not proposed to investigate every complicated species or variety which mineralogists have described. The following classification will answer the present purpose:

Metals; including the alloys.

Oxydes; whether simple or complicated.

Salts; comprising carbonats, sulphats, muriats, phosphats, arseniats, molybdats, tungstats, chromats and silicats; or combinations of more than one of these.

Sulphurets; simple or complicated.

Phosphurets.

We do not yet know how many metals can be separated from their solutions in a metallic state; but gold, silver, copper, and lead, can be procured in this manner with great facility. These may, therefore, be metals of an aqueous origin. Possibly this may happen to many others, from deoxydating processes in nature which we either have not examined, or which may be unattainable in our experiments.

All the metallic oxydes which involve a large number of these minerals, can be procured in the same manner; at least in a powdery state. If artificial chemistry has not yet contrived to obtain these in a crystallized form, it must be recollected that we cannot, like Nature, command the elements of time. Yet, perhaps, the case of oxydulous iron, which may be procured from the muriat by dissipating the acid, may be esteemed an instance in point; although the application of heat is necessary for this purpose. The oxyde appears here to crystallize at the moment of its separation from the acid,

without the necessity of a dry or subliming heat, although it is not easy to ascertain the exact nature of this process.

If chemistry has not yet formed every complicated salt that is found in the list of metallic saline minerals, it has produced so many that we may, with little hazard of error, consider the aqueous process as fully competent to the production of the whole. That nature can exhibit some of them in a crystallized form, such as the phosphat of iron, for example, when we can only obtain them in our laboratories in a powdery one, must be referred to the cause just noticed; namely, the rapidity of our operations and the slowness of her's. As to the silicats, our acquaintance with the real nature of this combination, or the exact mode in which silica acts the part of an acid, is as yet so recent and imperfect, that no opinion can at present be given respecting them.

The igneous theory of metallic veins was supposed to be supported by an incontrovertible argument derived from the sulphuret of iron, which, it was asserted, could not possibly be formed from aqueous solution; and the same rule was in consequence extended to all the other sulphurets. We shall shortly see that nature does produce it from aqueous solutions abundantly. In the laboratory it can be procured, merely by allowing the serum of blood to stand for some time; and, it is also obtained from the decomposition of sulphat of iron by animal matters. There is little doubt that other metallic sulphurets may be formed in the same manner; and, it is a subject that requires to be further investigated by those who may have leisure for this purpose. These combinations can also be procured in the aqueous method, by means of sulphuretted hydrogen; a very probable agent in nature. In these latter cases the sulphurets are only obtained in a powdery form; but in the former the iron pyrites is crystallized.

Respecting the phosphurets, our direct experience is next to nothing; but it must be remarked at the same time, that this is at least a rare if not a doubtful modification of the metallic minerals. But the methods of decomposing the sulphuric and

the phosphoric acids are so like, and all the points of analogy between sulphur and phosphorus are so strong, that it is safe to infer that phosphurets might be procured in the moist way as well as sulphurets.

In now examining the evidence which nature affords from the intimate association that exists between certain metallic minerals and those earthy ones which are ascertained to be of aqueous origin, it may be remarked that the chief of these latter are calcareous spar and quartz. Barytes and fluor are less conspicuous in this respect. The union with calcareous spar is rather more frequent than that with quartz; but, as these different earthy minerals frequently occur together, and particularly quartz and calcareous spar, it is not necessary to distinguish the metallic ones that seem to be in some cases peculiarly associated either with the one or with the other. The following list, therefore, contains those which are found in these associations, arranged according to their chemical natures, and under the most general terms.

METALS AND ALLOYS.

Gold.	Bismuth.
Silver.	Tellurium.
Arsenical silver.	Mercury and silver; (amalgam.)
Iron.	Antimony.
Copper.	Arsenical iron; (pyrites).
Arsenical Cobalt; (white cobalt).	Arsenical nickel (kupfer nickel).

OXYDES.

Copper; black and red.	Arsenical oxyde.
Iron; oxydulous. Hematite.	Uranium; green and black.
Lead; minium.	Manganese; red and black.
Titanium; rutile, anatase.	Cobalt; red and black.

SALTS.

Silver; muriat.	Tungsten; wolfram.
Copper; muriat, arseniat, phosphat.	Zinc, carbonats.
Lead; phosphat, carbonat, sulphat, molybdat.	Bismuth; carbonat.
Iron; muriat, arseniat, carbonat, phosphat.	Titanium; silicat. (Sphene).

SULPHURETS.

Silver.	Zinc.
Copper ; yellow, grey.	Arsenic. Arsenic and iron.
Lead, lead and antimony.	Antimony ; red and grey.
Mercury ; brown, red.	Bismuth.
Iron.	

The minerals which seem to carry the evidence of an aqueous origin in their forms are the following :

Earthy phosphat of iron.	Stalactitical manganese oxyde,
Stalactitical hæmatites.	red and black.
Bog iron ore.	Stalactitical calamine.
Malachite.	Stalactitical pyrites, whether of iron or copper.

The last list is that which contains the minerals found in secondary strata of aqueous deposition, and which do not appear to have experienced the influence of fire.

Gold.	Oxydulous iron.
Quicksilver.	Iron pyrites.
Muriat of quicksilver.	Hematites.
Sulphuret of quicksilver.	Iron stones and ochres.
Blue carbonat of copper.	Cobalt ; black oxyde.
Green carbonat of copper.	Manganese ; black oxyde.

All of these are found in the preceding enumeration ; so that these situations only offer proofs in confirmation of the present views.

I must now proceed to examine the minerals, whether earthy or metallic, which are the produce of igneous fusion, or of sublimation from a state of vapour. The evidence respecting these is also derived from two sources ; from chemical experience, and from their positions in rocks which are known to be the produce of fire. These last may be limited to granite, the traps, and the volcanic rocks, though there seems no reason to doubt that gneiss, micaceous schist, and other primary strata might be added to these ; in which case the catalogue might be still further increased.

The earthy minerals which may be modified by artificial fire, or which undergo the action of heat without destruction, are the carbonats of lime, barytes and strontian, and the phosphat of lime. Silica is sublimed in a crystalline form.

Of the metallic minerals it appears that every metal may be

sublimed by artificial heat; and they all admit of being crystallized by fusion. All the sulphurets admit of being fused; all appear capable of being sublimed; and, probably the whole can also be produced in this way by a direct combination of their ingredients. All the oxydes are produced from the metals by heat, and some of them admit of being volatilized. Under these circumstances also, some of them crystallize; as was observed in red oxyde of copper, formed in the cavities of metallic vessels in Pompeii. It is probable that some of the metallic salts, the arseniats for example, can be produced in this way; but I cannot quote any satisfactory experiments on a subject which, in all its bearings, is well worthy the attention of those chemists who are interested in geology, and whose leisure is greater than my own.

In examining the evidence which nature affords on this question, the following is a list of such earthy minerals as are found in the situations above-mentioned. It is probable that many are omitted, as no evidence but what seemed unexceptionable has been taken; and, in examining the entire catalogue of minerals, it will easily be found that there are some of which the origin still remains uncertain, and which are therefore excluded both from the aqueous and the igneous lists.

EARTHY MINERALS.

Quartz (by fusion and by sublimation.) Garnet.

Felspar.	Cyanite.
Mica.	Zircon.
Hornblende.	Fluor spar.
Actinolite.	Spodumene.
Chlorite.	Corundum.
Steatite.	Beryl.
Serpentine.	Topaze.
Chrysoberyl.	Tourmalin.
Epidote.	Schorl.
Apatite.	Tremolite.
Pinite.	Emerald.
Idocrase.	Gabbroinite.
Anthophyllite.	Wernerite.
Andalusite.	Pyrophysalite.
Stilbite.	Lapis lazuli.
Jade.	Asbestus.

Fettstein.	Hypersthene.
Talc.	Diallage.
Opal.	{ Augit.
	{ Sahlite.
Chrysoprase.	Peridot (by fusion, and by sublimation.)
Hauyne.	Melilite.
Meonite.	Tabular spar.
Sommite.	Melanite.
Leucite.	Idocrase.
Pseudosommite.	Ice spar.
Pleonaste.	Arragonite.

Together with some other volcanic minerals, which are yet ill defined.

The metallic minerals, thus found, are the following :

Copper.	Sphene.
Oxydulous iron.	Iron pyrites.
Galena.	Oxyde of Tin.
Graphite.	Sulphuret of molybdena.
Chromat of iron.	

Such is the balance, as far as it yet appears possible to construct a tolerable list of this nature, between the aqueous and the igneous minerals. It would be highly improper, in the present state of things, to deduce from it any thing respecting a theory of mineral veins. For, though all the minerals of these were aqueous, or all igneous, we are equally at a loss to conjecture whence they came, and how they are so limited and so disposed as they are in veins. It might indeed be considered an argument in favour of an igneous theory, that the mines of Nagyag lie in volcanic rocks. But it is evident that this fact proves no more in this case than in that of granite or trap ; since, in all of these rocks alike, aqueous infiltration takes place, as well into the veins as into the volcanic and trap amygdaloids.

But it is here worthy of remark, that of the earthy minerals actually found in mineral veins, there are more of an aqueous than of an igneous origin ; although there are many more igneous than aqueous minerals in nature. With respect to the metallic ones, the difference is still more in favour of the aqueous minerals. That many of both kinds have a double

origin, is only one out of the numerous difficulties that beset this subject. These are, in fact, such, and so apparently insurmountable at present, that a prudent geologist can do no better than suspend his judgment on the subject; provided he does not also suspend his investigations. Both the theories are before him, and he ought to try the facts by both, not by one only, to the exclusion of the other. In this pursuit, he ought to take into his views the formation of minerals by sublimation, and their production from infiltration; two processes which have been neglected by former theorists. Not, however, that these will, on either side, form in themselves a theory; because even were there not many more unintelligible circumstances in veins, we are still unable to explain whence, on either hypothesis, the minerals have arrived at their present places.

J. MAC CULLOCH.

ART. III. *Description of the Great Bandana Gallery, in the Turkey Red Factory of Messrs. Monteith and Co., at Glasgow.*

THE benefits of liberal-mindedness are nowhere more fully displayed than in the modern advancement of our chemical arts. A quarter of a century ago, manufacturing chemists were wont to shroud their operations in mysterious secrecy, like the craftsmen of the dark ages, on a supposition, usually unfounded, of their being possessed of some wonder-working recipes, whose promulgation would be fatal to their interests. At that period, the monied proprietors of chemical factories were rarely practical chemists. They were, therefore, obliged to place entire dependance in certain operative adepts, whom they engaged at a considerable salary, to conduct their processes. These persons, having been previously employed as subordinate menials in some similar manufactory, had acquired a smattering notion of the routine of working: but, being entirely destitute of education, and having no general views concerning the business which they undertook to manage, they were perpe-

tually falling into difficulties, and committing mistakes from time to time of the most ruinous description. Slight variations in the qualities and state of the materials employed, in the mode of mixture, in the temperature, or duration of the process, occasioned variations of result, which they could neither foresee, regulate, nor counteract; and, though the profits might be considerable on a successful operation, yet failures were so frequent and so expensive as to render the business not a little precarious and uncomfortable. Hence we can understand why chemical manufactories have undergone such vicissitudes of fortune,—some raising their proprietors to unexpected opulence, others sinking them to unlooked-for ruin.

The owners of chemical establishments, becoming at length impatient of the vassalage in which they had been long held by blundering and obstinate hirelings, began to inquire into the principles of their peculiar arts, and were thus led to cultivate the society of men of science. They now, for the first time, learned that economy and precision could be ensured to their processes only, by applying the same scientific rules which medical censorship, backed by the authority of law, had for a considerable time introduced with the happiest effect into the formerly mysterious and uncertain processes of pharmacy. Under this conviction, they consulted the chemical philosopher on their difficulties and disappointments. Suggestions, of greater or less value, were thus given and acted on, which led to new questions on the part of the manufacturer, and new researches on that of the chemist: and thus an alliance began between theory and practice, which has, in a very few years, carried several of the chemical arts of this country to an extraordinary pitch of perfection.

Instances have, undoubtedly, occurred of chemists of some reputation having given delusive advice to the manufacturer; as we see chemical authors publish, as processes of art, formulæ very disadvantageous and even absurd. These misdirections are almost always to be ascribed either to neglect of experimenting with due care on an adequate scale, or to superficial acquaintance with the principles of the science. It is very pos-

sible for a person to compile a dazzling series of class experiments with grandiloquent explications, without being either a philosophical or a practical chemist.

The league between science and art, which has, in this country, been the slow growth of necessity, was long ago effected in France, to a considerable extent, by authority of the government. The illustrious minister, Colbert, fraught with the most enlightened views of state policy, founded a school of science to superintend and assist the dyeing manufactories of the kingdom. From that school, conducted as it has been by a succession of eminent philosophers, have emanated invaluable researches on the most beautiful, but, at the same time, most intricate, of all the chemical arts,—researches to which France owes much of her eminence in this very profitable branch of her national industry.

The manufactory of Messrs. Monteith and Co. has been long celebrated in the commercial world for the excellence and beauty of its cotton fabrics. The madder-reds rival in brilliancy and solidity any ever produced at Adrianople; and the white figures, distributed over the cloth, surpass, in purity, elegance, and precision of outline, the original Bandana designs.

The opulent and enlightened proprietors have been careful to avail themselves of every resource which the latest improvements in chemistry and mechanics could supply. In this respect, their factory deserves to be studied as a school of practical science. The permission now granted of describing their discharging-gallery is a proof of their liberality, as well as of the confidence justly entertained, that the capital and skill, now engaged in their establishment, are better securities for the preference which their goods possess in the European market, than the utmost mystery in conducting their processes.

Hence they have rarely refused to strangers, respectable for their rank or science, permission to visit their manufactory,—a favour which it is impossible to enjoy without being gratified and instructed.

Their new arrangement of hydrostatic presses was completed

in 1818, under the direction of Mr. George Ridger, senior, manager of the works. It consists of sixteen of these engines beautifully constructed, placed in one range in subdivisions of four; the spaces between each set serving as passages to admit the workmen readily to the back of the press. Each subdivision occupies twenty-five feet; whence the total length of the apparatus is one hundred feet.

To each press is attached a pair of patterns in lead, (or *plates* as they are called,) the manner of forming which will be described in the sequel. One of these plates is fixed to the upper block of the press. This block is so contrived that it turns on a kind of universal joint, which enables this plate to apply more exactly to the under plate. The latter rests on the moveable part of the press, commonly called the *sill*. When this is forced up the two patterns close on each other very nicely by means of guide-pins at the corners, fitted with the utmost care.

The power which impels this great hydrostatic range is placed in a separate apartment, called the *machinery-room*. This machinery consists of two cylinders of a peculiar construction, having cylindric pistons accurately fitted to them. To each of these cylinders three little force-pumps, worked by a steam-engine, are connected.

The piston of the larger cylinder is eight inches in diameter, and is loaded with a top-weight of five tons. This piston can be made to rise about two feet through a leather stuffing or collar. The other cylinder has a piston of only one inch in diameter, which is also loaded with a top-weight of five tons. It is capable, like the other, of being raised two feet through its collar.

Supposing the pistons to be at their lowest point, four of the six small force-pumps are put in action by the steam-engine, two of them to raise the large piston, and two the little one. In a short time, so much water is injected into the cylinders, that the loaded pistons have arrived at their highest points. They are now ready for working the hydrostatic discharge-presses, the water pressure being conveyed from the one apart-

ment to the other under ground through strong copper tubes of small calibre.

Two valves are attached to each press, one opening a communication between the large *prime-cylinder* and the cylinder of the press, the other between the small *prime-cylinder* and the press. The function of the first is simply to lift the under-block of the press into contact with the upper-block; that of the second is to give the requisite compression to the cloth. A third valve is attached to the press, for the purpose of discharging the water from its cylinder, when the press is to be relaxed, in order to remove or draw through the cloth.

From twelve to fourteen pieces of cloth, previously dyed Turkey-red, are stretched over each other, as parallel as possible, by a particular machine. These parallel layers, are then rolled round a wooden cylinder, called by the workmen, a drum. This cylinder is now placed in its proper situation at the back of the press. A portion of the fourteen layers of cloth, equal to the area of the plates, is next drawn through between them, by hooks attached to the two corners of the webs. On opening the valve connected with the eight inch *prime-cylinder*, the water enters the cylinder of the press, and instantly lifts its lower block, so as to apply the under plate with its cloth, close to the upper one. This valve is then shut, and the other is opened. The pressure of five tons in the one inch *prime-cylinder*, is now brought to bear on the piston of the press, which is eight inches in diameter. The effective force here will, therefore, be $5 \text{ tons} \times 8^2 = 320 \text{ tons}$; the areas of cylinders being to each other, as the squares of this respective diameters. The cloth is, therefore, condensed between the leaden pattern-plates, with a pressure of 320 tons.

The next step, is to admit the blanching or discharging liquor, (aqueous chlorine, obtained by adding sulphuric acid to solution of chloride of lime,) to the cloth. This liquor is contained in a large cistern, in an adjoining house, from which it is run at pleasure into small lead cisterns attached to the presses; which cisterns have graduated index tubes, for regulating the quantity

of liquor according to the pattern of discharge. The stop-cocks on the pipes and cisterns containing this liquor, are all made of glass.

From the measure-cistern, the liquor is allowed to flow into the hollows in the upper lead-plate, whence it descends on the cloth, and percolates through it, extracting in its passage, the Turkey red dye. The liquor is finally conveyed into the waste pipe, from a groove in the under block. As soon as the chlorine liquor has passed through, water is admitted in a similar manner, to wash away the chlorine; otherwise on relaxing the pressure, the outline of the figure discharged, would become ragged. The passage of the discharge liquor, as well as of the water through the cloth, is occasionally aided by a pneumatic apparatus, or blowing machine; consisting of a large gasometer, from which air subjected to a moderate pressure, may be allowed to issue, and act in the direction of the liquids, in the folds of the cloth. By an occasional twist of the air stop-cock, the workman also can ensure the equal distribution of the discharging liquor, over the whole excavations in the upper plate. When the demand for goods is pressing, the air apparatus is much employed, as it enables the workman to double his product.

The time requisite for completing the discharging process in the first press, is sufficient to enable the other three workmen to put the remaining fifteen presses in play. The *discharger* proceeds now from press to press, admits the liquor, the air, and the water; and is followed at a proper interval by the assistants who relax the press, move forwards another square of the cloth, and then restore the pressure. Whenever the sixteenth press has been liquored, &c., it is time to open the first press. In this routine, about ten minutes are employed; that is 224 handkerchiefs (16×14) are discharged in ten minutes. The whole cloth is drawn successively forward, to be successively treated in the above method.

When the cloth escapes from the press, it is passed between two rollers in front; from which it falls into a trough of water

placed below. It is finally carried off to the washing and bleaching department, where the lustre of both the white and the red is considerably brightened.

By the above arrangement of presses, 1600 pieces, consisting of 12 yards each $\equiv$ 19,200 yards, are converted into Bandanas in the space of ten hours, by the labour of four workmen.

The patterns, or plates, which are put into the presses to determine the white figures on the cloth, are made of lead, in the following way. A trellis frame of cast-iron, one inch thick, with turned-up edges, forming a trough rather larger than the intended lead pattern, is used as the solid groundwork. Into this trough, a lead plate about one half inch thick, is firmly put by screw nails passing up from below. To the edges of this lead plate, the borders of the piece of sheet-lead are soldered, which covers the whole outer surface of the iron frame. Thus a strong trough is formed, one inch deep. The upright border gives at once great strength to the plate, and serves to confine the liquor. A thin sheet of lead, is now laid on the thick lead-plate, in the manner of a veneer on toilette-tables, and is soldered to it, round the edges. Both sheets must be made very smooth beforehand, by hammering them on a smooth stone table, and then finishing with a plane: the surface of the thin sheet (now attached), is to be covered with drawing paper pasted on, and upon this, the pattern is drawn. It is now ready for the cutter. The first thing which he does, is to fix down with brass pins, all the parts of the pattern, which are to be left solid. He now proceeds with the little tools generally used by block cutters, which are fitted to the different curvatures of the pattern, and he cuts perpendicularly quite through the thin sheet. The pieces thus detached are easily lifted out; and thus, the channels are formed, which design the white figures on the red cloth. At the bottom of the channels, a sufficient number of small perforations are made through the thicker sheet of lead, so that the discharging liquor may have free ingress and egress. Thus, one plate is finished; from which, an impression is to be taken by means

of printers' ink, on the paper pasted on another plate. The impression is taken in the hydrostatic press. Each pair of plates constitutes a set, which may be put into the presses, and removed at pleasure.

Plate VI. is an elevation of one press ; A, the top, or entablature ; BB, cheeks of ditto, or pillars ; C, upper block for fastening upper pattern to ; D, lower or moveable block ; E, the cylinder ; F, the sole or base ; G, the water trough for the discharged cloth to fall into ; H, cistern or liquor-metre ; dd, glass tubes for indicating the quantity of liquor in the cistern ; ee, glass stop-cocks for admitting the liquor into the cistern ; ff, stop-cocks for admitting water ; gg, the pattern-plates ; nn, screws for setting the patterns parallel to each other ; mm, snuffs perforated with a half inch drill. The lower iron frame has corresponding pins, which suit these perforations, so that the patterns are guided into exact correspondence with each other ; hh, rollers which receive and pull through the discharged cloth, from which it falls into the water-box ; k, stop-cock for filling the trough with water ; iii, waste tubes for water and liquor.

Glasgow, May 30th, 1823.

ART. III. LAMARCK'S *Genera of Shells.*

[Continued from Vol. XV. p. 52.]

CLASS XII.

MOLLUSCA*.

ANIMAL soft, not articulated, having a head, which forms a fleshy eminence on the fore part of the body, more or less prominent, often of a round shape and generally furnished with eyes, and sometimes, with from two to four, or at most, six tentacula ; sometimes surmounted by arms on the summit, disposed in the form of a crown. Mouth, whether short or

* *Molluscus soft* ; an old word, nearly obsolete, derived from the Greek *μαλακός*.

elongated, tubular, exsertile, and usually armed with hard parts. Mantle various, either with the margins free, at the sides of the body, or with the lobes united into a bag which partly envelopes the animal.

Branchiæ various, rarely symmetrical, circulation double, one particular, the other general. Heart unilocular, occasionally with two divided, very remote auricles. No ganglionated medullary cord, but a few dispersed ganglia, and different nerves.

Body sometimes naked, either with no internal solid parts, or enclosing a shell, or some hard substance; sometimes furnished with an external covering, or ensheathing univalve shell. Shell never composed of two opposite valves united by a hinge.

The distinguishing character of the mollusca, is that they have no vertebræ, are wholly without articulations in all their parts, and have a more or less prominent head at the anterior portion of the body.

The body of these animals is fleshy, soft, and eminently contractile, and endowed with the power of reproducing the parts that may have been destroyed. It is covered with a soft skin, moistened by a viscous glutinous fluid, which continually exudes from it; the skin forms the true covering of the animal, and is wholly independent of the solid testaceous envelope. The blood of the mollusca is white or bluish; their muscles are white and very irritable, attached beneath the skin to the substance of the mantle. The body is elongated, sometimes oval, slightly depressed, sometimes straight, and sometimes spiral at the hinder part. They have no true lungs, but respire by the branchiæ. Their mouth is generally furnished with hard parts; in some it is short, and has two jaws; in others, it consists of a retractile trunk, with small teeth at its internal orifice, but no jaws. The mollusca, which are furnished with the trunk, as the *buccina*, *volutæ*, &c., are carnivorous, using it to perforate the shells of other shell-fish, in order to prey on the animal within. Those with strong horny

jaws, (the cephalopoda,) shaped like a parrot's bill, also live on animal food. The limaces, helices, bulimi, and all that have cartilaginous jaws, furnished with very minute teeth, almost invisible, but sensible to the touch, live on herbs or fruits.

The foot consists of a fleshy, muscular, and glutinous disk ; it serves the animal to crawl with, and is placed at the lower surface of the body, either on the fore part, or extending through its whole length. The crawling foot is peculiar to the gasteropoda and the trachelipoda. The mollusca, which have non-operculated shells, have but one muscle of attachment, situated near the middle of the back ; those with opercula have two, one which connects the animal with the shell, the other belonging to the operculum. The operculum is usually round, solid, horny or calcareous, and serves to close the mouth of the shells when the animal is in a state of repose ; when it comes out of the shell, it carries the operculum with it, and on retiring it re-adjusts this natural door to the entrance of its dwelling*. Some mollusca are naked, that is, have no external shell, and are quite soft in all their parts—others, though naked without, are provided with one or more solid bodies internally, which sometimes are simply cartilaginous or horny, sometimes cretaceous and lamellar, constituting a true internal shell. This shell is usually spiral, and its cavity simple or undivided, as in the bullææ, bullæ, sigareti, &c., but in many of the cephalopoda, it is multilocular, its cavity being divided into several regular chambers, by transverse partitions.

Other mollusca have shells, which are wholly external.

The mollusca are in general aquatic animals. Most of

* The *helix pomatia* has a very solid, calcareous operculum ; with which it firmly closes the mouth of its shell at the approach of winter. The wonderful rapidity with which the animal secretes the matter to form this external defence, is strikingly exhibited in the following experiment, communicated by Mr. Henry Stutchbury. This gentleman and his brother, took a *helix pomatia* on a warm summer's day, when it was quite destitute of any operculum, (for it casts it off at that season,) and placed it in a vessel, surrounded by a freezing mixture. In the short space of twelve hours it formed a complete solid operculum, in every respect similar to the natural one, except that it was not quite so thick.—Tr.

them inhabit the sea; others live in fresh water; and others, again, in moist, shady places, on land. Some of the latter, however, are capable of supporting the heat of a brilliant sunshine.

This class is divided into the five following orders:

First Order.

PTEROPODA *.

No foot, or arm, for crawling or seizing its prey. Two opposite and similar fins, (nageoires,) adapted for swimming. Body free, floating.

Second Order.

GASTEROPODA †.

Body straight, never spiral, nor enveloped in a shell capable of containing the whole of it. Foot muscular, united to the body nearly through its whole length, situated under the belly, and formed for crawling.

Third Order.

TRACHELIPODA ‡.

Body in great measure spiral, separate from the foot, and always covered by a spirivalve shell. Foot free, flat, attached to the inferior base of the neck, and formed for crawling.

Fourth Order.

CEPHALOPODA §.

Body, except the head, contained in a bag-shaped mantle. Head projecting beyond the bag, crowned with inarticulated arms, furnished with air-holes, and surrounding a mouth with two horny mandibles.

Fifth Order.

HETEROPODA ||.

No coronet of arms on the head; no foot, for crawling, under

* From πτερον, a wing, and πους, a foot.

† From γαστήρ, the belly, and πους, a foot.

‡ From τραχηλος, the neck, and πους, a foot.

§ From κεφαλη, the head, and πους, a foot.

|| From ἕτερος, different, and πους, a foot.

the belly or neck. One or more fins, not disposed in pairs, or regular order.

First Order.

PTEROPODA.

Most of the Pteropoda are small animals, with no appendices, or only very short ones on the head. Some have a thin cartilaginous or horny shell, and some have branchial fins.

1st Family.

HYALÆANA. (6 Genera.)

1. *Hyalæa* *.

Body covered with a shell; two opposite, rather large, retractile fins inserted at each side of the mouth. Scarcely any head. Mouth terminal, situated at the junction of the fins. No eyes. Branchiæ lateral. Shell horny, transparent, ovate-globular, posteriorly tridentate, open at the summit and two posterior sides.

The shell of the *Hyalæa* appears, according to Forskahl, to consist of two valves cemented together. The valves are unequal; the largest, dorsal, rather flattened below, the other ventral, tumid, subglobular, and shortened anteriorly. The middle one of the three posterior teeth, or points, is perforated. On each side of the shell, is a very open fissure, to admit the water to the branchiæ.

Type. *Hyalæa tridentata* †. (*Monoculus telemus*? Linn.)

Shell yellowish, pellucid, thin, very delicately striated transversely; terminal point longer than the lateral.

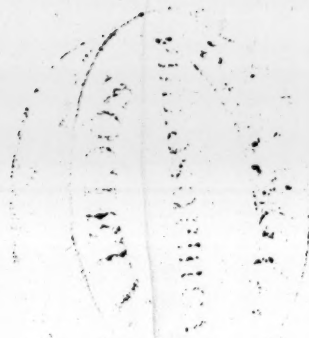
Mediterranean. 2 Species. Pl. VII. Fig. 106 †.

* From *υαλος*, glass.

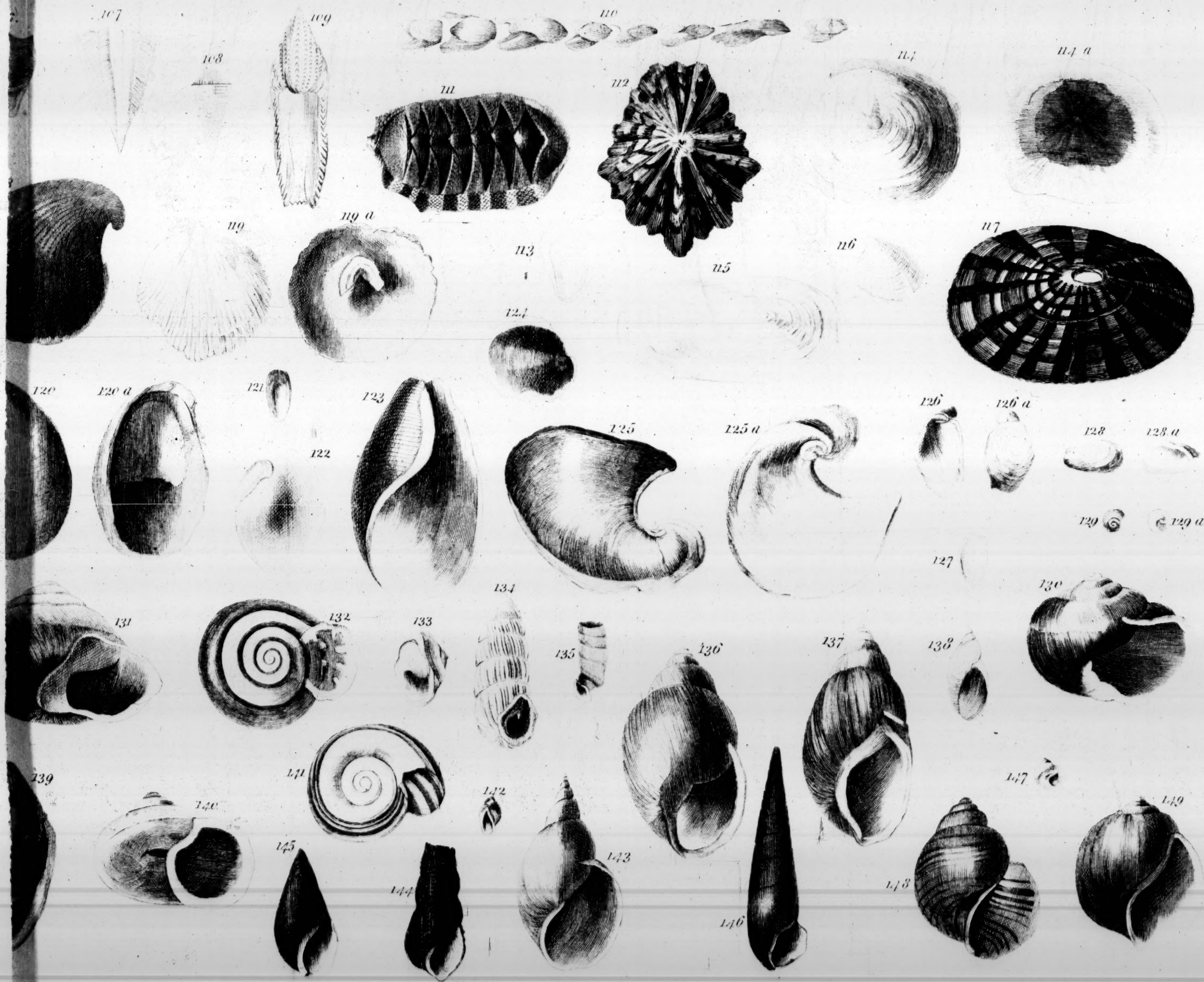
† Having three teeth.

‡ We have given a figure of another, and, we believe, hitherto unpublished, genus, which seems to belong to this family. It was collected by the late Mr. Cranch, on the Congo Expedition, and presented to the British Museum, (where it is preserved, with another species, apparently of the same genus,) by the Lords Commissioners of the Admiralty. We propose to call it, at the suggestion of a kind and learned friend, *Balanium recurvum* ^a. As the animal inhabitant, however, is quite unknown to us, we place it in this family, merely from the strong analogy which the

^a From *βαλανιον*, a purse; *recurvum*, *recurved*—the apex being bent.







2. *Clio*.

This genus has no shell.

3. *Cleodora*.

Body oblong, gelatinous, contractile, bi-alate; the head on the anterior part of the body, the posterior covered with a shell. Head projecting, very distinct, rounded, with two eyes, and a small subrostrated mouth. No tentacula. Two opposite membranous, transparent, cordate *alæ* *, inserted at the base of the neck.

Shell straight, gelatino-cartilaginous, transparent, in the form of a reversed pyramid, lanceolate, truncated and open at the top.

These animals, like the rest of the Pteropoda, float at random, in the sea.

Type. *Cleodora pyramidata* †. (*Clio pyramidata*. Linn.)

Shell triangular, pyramidal, short; mouth obliquely truncated. *American Ocean*. 2 species. Pl. VII. Fig. 108.

4. *Limacina* †.

Body soft, oblong, anteriorly very similar, in regard to the head and *alæ*, to the *clio*; but spirally contorted, at the hinder part, and enclosed in a shell.

Shell thin, brittle, papyraceous, spiral; turns of the spire united in a discoidal order, like the planorbis.

The limacina is ill named, for it rather resembles a helix than a limax; but the shell being flattened on the upper part,

substance of the shell bears to that of the *Hyalæa*, until an opportunity may occur of obtaining more accurate information respecting this interesting species. It may be described as follows.

Shell transparent, very thin and fragile, hyaline, corneous, hastiform, apex recurved; open at both ends; superior aperture dilated, sharp edged; inferior round, very minute; sides acute; superior disk undulated; inferior rounded; numerous transverse grooves on both sides. P. VII. Fig. 107. The figure given (Plate vii. No. 8.) in Mr. Parkinson's *Introduction to the Study of Fossil Organic Remains*, as a *Hyalæa*, very much resembles the other species of this genus, alluded to above.

* Wings. Two membranes, situated as described in the text, which, when extended, serve as sails, whilst the animal is floating on the surface of the water.

† *Pyramidal*.

‡ From *limax*, a snail.

from the whorls being united in a discoidal form, makes it still more like a planorbis. It differs from the Cleodora, merely by being spiral.

One Species. *Limacina helicalis**. (Clio helicina. Gmel.)

North Seas. Whales are said to prey on the Limacina.

5. Cymbulia †.

Body oblong, gelatinous, transparent, enclosed in a shell. Head sessile ‡; two eyes; two retractile tentacula; mouth furnished with a retractile trunk. Two opposite, rather large, rounded oval, branchiferous alæ, connected, at the posterior base, by an intermediate, lobe-shaped appendix.

Shell gelatino-cartilaginous, very transparent, crystalline, oblong, in shape like a shoe, truncated at the summit; aperture lateral, anterior.

One Species. *Cymbulia peronii* §.

Mediterranean, near Nice. Length about two inches. Pl. VII. Fig. 109.

6. Pneumodermon ||.

This genus has no shell.

Second Order.

GASTEROPODA. (Contains 7 Families.)

Body of the animal straight, never spiral, nor enveloped by a shell, capable of containing it wholly; a foot, or muscular disk under the belly, united to the body nearly through its whole length, and used in crawling.

Some of the individuals of this order are naked, others have a dorsal, but not enveloping shell, and others have an internal shell, more or less hid under the mantle.

The Gasteropoda are divided into seven families; viz., Tritoniana, Phyllidiana, Semi-Phyllidiana, Calyptraciana, Bullæ-

* Resembling a helix.

† From cymbula, a little boat.

‡ That is, without any distinct neck.

§ Of M. Péron.

|| From πνεύμων, the lungs, and δερμα, the skin.

ana, Laplysiana, and Limaciana. None of the animals of the first family have any shell; we proceed, therefore, to the

2d Family.

PHYLLIDIANA, (4 genera.)

Branchiæ situated under the border of the mantle, and disposed in a longitudinal series round the body. The individuals of this family respire water only.

Some of the Phyllidiana have no shell, either external or internal; others are wholly, or in part, covered by a shell, sometimes composed of one single piece, sometimes of a range of moveable and distinct pieces.

1. Phyllidia.

This genus has no shell.

2. Chitonellus*.

Body creeping, elongated, rather narrow, resembling a caterpillar; a multivalve shell on the middle of the back, through its whole length, like a riband; valves alternate, longitudinal, almost connected by their extremities; sides of the back naked. Branchiæ disposed like those of the Chitones; foot divided longitudinally by a deep furrow.

The valves of the shell, whilst the animal is alive, are separate; but, when dead and contracted, several of them appear to be united. The Chitonellus is nearly allied to the Chiton; but the looser disposition of the dorsal shell admits of greater freedom of motion to the right or left, and suffers the animal to bend its body to either side with facility, like a worm. The longitudinal furrow in the foot, probably serves for crawling on the stems of marine plants.

Type. *Chitonellus lævis* †.

Shell with smooth small valves; margins very entire; last valve pointed posteriorly.

New Holland. 2 Species. Pl. VII. Fig. 110.

* Little Chiton.

† Smooth.

3. Chiton *.

Body creeping, oval oblong, convex, rounded at the extremities, bordered all round by a coriaceous skin, and partly covered by a longitudinal series of testaceous, imbricated, transverse, moveable pieces, connected with the borders of the mantle. Head anterior, sessile; mouth situated at the lower part, covered by a membrane, and furnished with numerous teeth, some simple, some with three points, and disposed in several longitudinal rows. No tentacula nor eyes. Branchiæ disposed in series round the whole body under the border of the skin; anus below the posterior extremity.

The shell of the Chiton is generally composed of eight valves, sometimes of seven, or only six; the middle valves are rather larger than those at the extremities. They live in the sea at moderate depths, and near the shore; attaching themselves, but not permanently, to rocks and stones.

Type. *Chiton squamosus* †. (Idem. *Linn.*)

Shell with eight valves, semistriated; body covered with small scales.

Mediterranean, and American Seas. Six Species. Pl. VII, Fig. 111.

4. Patella ‡.

Body entirely covered by an univalve shell; two pointed tentacula on the head, with eyes at their exterior base. Branchiæ disposed in series all round the body, under the border of the mantle; anus and orifice for generation at the right anterior side.

Shell univalve, not spiral, enveloping, clypeiform, or flattened conical, concave and simple below; no fissure in the margin; summit entire, inclining to the anterior side.

The summit is often the thickest part of the shell, and the muscular attachment is very perceptible, on the concave side, in many of the species; and shews that the head of the animal is always placed on the side towards which the summit inclines.

† *χίτων*, a coat of mail.

† *Scaly*. Lamarck's second Species. His type is *C. gigas*.

‡ A small deep dis

The Patellæ are widest at the posterior side, and the periphery of the shell is usually oval. They seem to live habitually in the same place, though they probably have the power of changing their situation from time to time.

Linnæus or Gmelin classed the fissurella, emarginula, navicella, umbrella, pileopsis, calyptræa, and crepidula, all under the genus *Patella*.

Most of the Patellæ have ribs, radiating from the summit to the margin.

Type. *Patella granatina* *. (Idem, Linn.)

Shell angular, with numerous ribs and striæ; apex, both within and without, purplish black. *Antilles*. 45 species. Pl. VII. Fig. 112.

3d Family.

SEMI-PHYLLIDIANA. (2 genera.)

Branchiæ situated under the border of the mantle, and disposed in a longitudinal series, on the right side only of the body. The animals breathe water.

In the disposition of the branchiæ, the mollusca of this family have considerable resemblance to those of the preceding, except that in the Phyllidiana they occupy the whole of the canal, which encircles the body between the border of the mantle and the foot, whilst in the Semi-Phyllidiana they are found only in that *half* of the canal which lies on the right side,—whence the name. In other respects, the two families differ considerably; but, since the branchiæ are not placed, as in the succeeding families, in an insulated cavity, Lamarck has thought it necessary to assign them a distinct rank, in the order of the Gasteropoda.

1. Pleurobranchus †.

Body crawling, fleshy, oval-elliptic, covered by a projecting mantle; foot large and projecting like the mantle, so that the two form an intermediate canal, and the body appears as if en-

* Garnet-coloured.

† From πλευρα the side, and βραγχια, branchiæ, the lungs with which fishes breathe.

closed between two equal shields. Branchiæ on the right side, inserted in the canal, and disposed in series, on the two faces of a longitudinal lamina. Mouth anterior, proboscis-shaped, situated underneath. Two cylindrical, hollow tentacula, with an external longitudinal fissure, attached to the lamina which covers the mouth. Aperture of the organs of generation in front of the branchial lamina; anus behind; both on the right side.

Shell internal, dorsal, thin, flattened, often oblique-oval.

One species. *Pleurobranchus Peronii*.

No further description.

Indian Seas. Pl. VII. Fig. 113.

2. Umbrella.

Body very thick, subovate, furnished with a dorsal shell; foot very large, prominent, smooth and flat on the under part, notched before, posteriorly attenuated. Head not distinct; mouth at the bottom of a funnel-shaped cavity, situated in the anterior sinus of the foot. Four tentacula; two superior, thick, short, truncated, with a fissure on one side, internally, transversely sub-lamellar; two others thin, cristate, pedunculated, inserted at the sides of the mouth. Branchiæ foliaceous, arranged in series between the foot and the border of the mantle, through the whole length of the right side, both anterior and lateral. Anus behind the posterior extremity of the branchiæ.

Shell external, orbicular, rather irregular, almost flat, slightly convex above, white; apex small, near the middle; margin sharp; internal face slightly concave, presenting a callous, colourless disk, depressed in the centre, and surrounded by a smooth border.

M. de Blainville, who has described the animal of the umbrella under the name of *gastroplax*, says, that its "shell has been found adhering to the inferior face of the animal." M. Mathieu, however, who has seen the species alive, at the Isle of France, asserts that the shell is dorsal.

Type. *Umbrella Indica* †. (*Patella umbellata*, Gmel.)

* Our figure is copied from that in the *Annales du Muséum*. V. Pl. XVIII. Fig. 1 and 2.

† *Indian umbrella*, commonly called the *Chinese parasol*.

Shell somewhat concave, on the under side thin, and slightly transparent; disc divided by radiating striæ.

Indian Ocean, and common at the Isle of France. 2 Species.
Pl. VII. Fig. 114.

4th Family.

CALYPTRACIANA. (7 Genera.)

Branchiæ placed in a cavity on the back, near the neck, and projecting either in the cavity itself, or beyond it. The animals breathe only water.

Shell always external, covering.

The animals of this family, in respect of form and position of their shell, are nearly allied to the phyllidiana, especially the patellæ; but the situation of their branchiæ, in an insulated cavity on the back near the neck, sufficiently distinguishes them from the individuals of that family, and requires that they should be placed in a separate group. None of the shells belonging to the Calyptraciana are operculated, wherefore the navicella is decidedly excluded from this family. The seventh genus, ancylus, is placed in it for the present, till the organization of its animal inhabitant shall be more fully known.

1. *Parmophorus* *.

Body crawling, very thick, oblong-oval, rather widest at the posterior end, obtuse at the extremities; mantle, cleft in front, falling vertically over the body, and covered by a scutiform shell. Head distinct, situated under the cleft of the mantle, with two conical, contractile tentacula, with two eyes at their external base. Mouth below, hid in an obliquely truncated funnel. Branchial cavity opening anteriorly, but behind the head by a transverse fissure, and containing two lamellar, pectinate, projecting branchiæ. Orifice of the anus in the branchial cavity.

Shell oblong, subparallelopipedal, rather convex above, retuse at the extremities, anteriorly emarginate, sinus slight, apex small, inclining to the posterior side. Lower surface slightly concave.

Type. *Parmophorus australis* †.

* From *παρμα*, a shield, and *φέρω*, to bear.

† *Southern.*

Shell solid, smooth; of the same length as the back of the animal; margin rather thick.

New Holland. Pl. VII. Fig. 115. 4 Species.

2. *Emarginula**.

Body creeping. Two conical tentacula, with eyes at their external base; mantle very large, partly covering the shell with its folds; foot broad, and very thick.

Shell scutiform, conical; vertex inclined; cavity simple; posterior margin notched, or emarginate.

The shells of this genus are generally small; some of them are considerably convex, in form of a cone, inclined towards the anterior margin, which is always the narrowest, and opposite to that which has the fissure. In others, the cone is very much flattened, and scarcely perceptible.

Type. *Emarginula fissura* †. (*Patella fissura*, Linn.)

Shell oval, convex-conical, decussated with longitudinal ribs and transverse striæ, pellucid, whitish; vertex curved; margin crenate.

European seas. Pl. VII. Fig. 116. 2 recent species, and 3 fossil.

3. *Fissurella*‡.

Head of the animal truncated anteriorly. Two conical tentacula, with eyes at their external base; mouth terminal, simple, without jaws. Two pectinate branchiæ projecting from the branchial cavity on each side of the neck; mantle very ample, projecting beyond the shell; foot wide, very thick.

Shell scutiform, or depressed conical; concave on the under side; vertex perforated; foramen oval, or oblong; no spire.

Some of the *Fissurellæ* are of considerable size and thickness. The hole on the summit is never round.

Type. *Fissurella nimbosa* §. (*Patella nimbosa*, Linn.)

Shell ovate-oblong, convex, brownish white, with violet-brown rays; longitudinal striæ numerous, crowded; margin crenate; foramen oblong.

* Derived, we suppose, from *emarginatus*, in allusion to the fissure in the posterior margin.

† A fissure.

‡ Dim. from *fissura*, a little fissure.

§ Cloudy. Lamarck's second species; his type is *F. picta*.

South of Europe. Pl. VII. Fig. 117. 19 recent species, and 1 fossil.

4. *Pileopsis**.

Shell univalve, oblique-conical, curved forwards; summit bent, almost spiral; aperture rounded oval; anterior margin shortest, acute, terminating in a slight sinus; posterior margin larger, round; an elongated, arched, transverse muscular impression under the posterior border.

Animal.—Two conical tentacula, with eyes at their external base. Branchiæ disposed in a row under the anterior border of the cavity, near the neck.

According to M. DeFrance, it is probable that the animal of this species never removes itself from the place where it has once fixed. He observed, in some fossil species, a support formed for the shell, during the life of the animal, by successive depositions of testaceous matter, constituting a separate piece, attached to marine substances, and preserving, on its upper part, a pretty deep impression of the margin of the shell.

Lamarck subdivides this genus into, 1, Shells without any known support; and, 2, Shells with a support†. The first subdivision contains eight species, the second two. Only the first four species of the first subdivision are recent shells, all the rest are fossil.

Type. *Pileopsis ungarica*‡. (*Patella ungarica*. Linn.)

* From *πῖλος*, a *bonnet*, and *οψις*, *appearance*, denoting the bonnet shape of the shell.

† In the first number of his *Genera of recent and fossil shells*, Mr. G. B. Sowerby gave his reasons for considering the *Hipponix* of De France (*Pileopsis* of the second subdivision, *Lamarck*) to be a true bivalve shell, the “*support*” being, in fact, the lower valve; and in the 15th number, just published, he adds the following additional arguments in confirmation of his opinion: “*Lamarck's Calyptaciens are Gasteropodes*; the shell being a testaceous deposition from the mantle, and the *Gasteropodes*, not being furnished with such a mantle under their foot, could not possibly deposit testaceous matter in such a position, as to form what he has termed a support, but which should more properly be called another valve; consequently, his ‘*Cabochons ayant un support connu*’ should be placed among the *Conchifera*, or we must suppose the absurdity of a *Gasteropoda* depositing shelly matter from the lower part of its foot, where it is not furnished with the necessary organs.”—This appears to us to be perfectly conclusive.

‡ *Hungarian*.

Shell pointed, conical, striated; vertex curved, involute; aperture widest in the transverse direction, internally rose-coloured.

Mediterranean. Pl. VII. Fig. 118. 10 Species.

5. *Calyptræa*.

Animal unknown.

Shell conoidal, vertex erect, imperforate, subacute; base orbicular. Cavity furnished with an attached, convolute lamina, or spiral diaphragm.

Type. *Calyptræa equestris**. (*Patella equestris*. Linn.)

Shell suborbicular, convex-conical, thin, pellucid, white, with acute, undulated, subtuberculated, longitudinal striæ, increasing in size towards the margin; vertex subacute, curved. *Indian Ocean*. Pl. VII. Fig. 119.

6. *Crepidula*†.

Animal.....head forked anteriorly. Two conical tentacula, with eyes at their external base. Mouth simple, without jaws, and placed at the bifurcation of the head. Branchia single, subpenicillate, projecting beyond the branchial cavity, on the right side of the neck. Mantle never extending beyond the shell. Foot very small. Anus lateral.

Shell oval or oblong, convex externally, internally concave; spire very much inclined towards the margin; aperture partly closed by a horizontal lamina.

The shell of the *crepidula* not only covers the animal, but partly ensheathes it, for the chamber, formed by the lamina, always contains a portion of its body. It has no operculum. Found on rocks near the sea-side.

Type. *Crepidula fornicata*‡. (*Patella fornicata*. Linn.)

Shell oval, posteriorly obliquely curved; posterior lip concave.

Barbadoes. Pl. VII. Fig. 120. 6 species.

7. *Ancylus*§.

Body creeping, wholly covered by the shell. Two com-

* *Equestrian*. Lamarck's third species. His type is *C. extinctorium*.

† Dim. from *crepida*, a little shoe.

‡ Arched.

§ Is this a corruption of *ancile* or *ancilium*, a sacred shield? We can find no such word as *ancylus*. But this is not the only instance in which our author's Latin names are somewhat difficult to translate.

pressed, slightly truncated tentacula, with eyes at their internal base. Foot short, elliptical, rather narrower than the body.

Shell thin, obliquely conical; summit pointed, inclined backwards; aperture oval; margin very simple.

Type. *Ancylus lacustris**. (*Patella lacustris*. Linn.)

Shell semiovate, membranaceous; vertex subcentral; aperture suboblong-ovate. *France*. Pl. VII. Fig. 121. 3 Species.

5th Family.

BULLÆANA. (3 Genera.)

Branchiæ situated in a cavity, near the posterior part of the back, and covered by the mantle. No tentacula.

1. *Acera*.

This genus has no shell.

2. *Bullæa*†.

Body elongated oval, slightly convex above, divided transversely into an anterior and a posterior part. Lateral lobes of the foot, with rather a thick border, and reflected upwards. Head scarcely distinct. No tentacula. Branchiæ dorsal, situated under the posterior portion of the mantle. Shell concealed in the mantle, above the branchiæ, and not adhering to the animal by any muscular attachment.

Shell very thin, partially convolute, and spiral on one side; no columella, nor projecting spire; aperture very large, dilated at the upper part.

One Species. *Bullæa aperta*‡ (*Bulla aperta*. Linn.)

The last whorl of the volute, is terminated by the right margin of the aperture. *European Seas*. Pl. VII. Fig. 122.

3. *Bulla*§.

Body oblong-oval, slightly convex, divided at the upper part into two transverse portions; mantle posteriorly plicate. Head very indistinct. No apparent tentacula. Branchiæ dorsal, posterior; covered by the mantle. Anus on the right side. Posterior part of the body covered by an external shell, adhering by a muscular attachment. Shell univalve, oval-globular, convolute; no columella, nor projecting spire, or only

* Of the pools.

‡ Open.

† As nearly allied to the *bulla*;

§ A bubble.

very slightly elevated; aperture the whole length of the shell; right margin acute.

The *bulla* differs from the *bullæa*, by the shell being completely convolute, always visible externally, and only partially covered by the hinder part of the animal, which adheres to it by a muscular attachment. The animal even hides completely in the shell. In the *bullæa* the shell is imperfectly convolute, wholly concealed by the posterior part of the mantle, but not affixed to it, and not at all visible externally.

The genus *bulla* of Linnæus was very vague and inconveniently extensive, as is evident from his *B. ovum*, *achatina*, *ficus*, *terebellum*, &c., shells which belong to very different genera and even families. Bruguière reformed the genus, and distinguished it clearly from the *ovulæ*, but he left the *bullæa* in it, which Lamarck has since separated. The *bullæ* are generally ventricose shells.

Type. *Bulla lignaria**. (Idem. Linn.)

Shell oblong, loosely convolute, attenuated towards the spire, transversely striated, pale yellow; spire truncated; umbilicated. *European Seas*. Pl. VII. Fig. 123. 11 Species.

6th Family.

LAPLYSIANA. (2 Genera.)

Branchiæ placed in an appropriate cavity, near the posterior part of the back, and covered by an opercular scutcheon. Tentacula.

The *Laplysiana* resemble large limaces, but their body is broader, and larger towards the posterior part, and the borders of the mantle are more ample. The head projects considerably forward, and has four tentacula, two near the mouth, and two behind. The latter are the largest, nearly ear-shaped, or sometimes semi-tubular. They are distinguished from the *bullæana* by the opercular scutcheon which covers the branchial cavity, which, as well as the tentacula, is wanting in that family. This scutcheon contains a horny or cretaceous piece, the element of a shell, which has never the singular convolution of that of the *bulla*, or *bullæa*. The *laplysiana* breathe only water.

* *Belonging to wood*.

1. *Laplysia* *.

Body creeping, oblong, convex, bordered on each side by a wide mantle, which, when at rest, covers the back. Head supported by a neck; four tentacula, two superior, auriform†, two near the mouth. Eyes sessile, in front of the auriform tentacula. Scutcheon dorsal, semi-circular, subcartilaginous, fixed by one side, and covering the branchial cavity. Anus behind the branchiæ.

The mouth of the *laplysia* is cleft longitudinally, almost like that of a hare, and the cavity of the stomach is lined with little solid semi-cartilaginous, pyramidal bodies, which defend the internal surface of that organ. The *laplysia* swims with ease, but crawls slowly.

Type. *Laplysia depilans*†. (Idem. Linn.)

Body livid, blackish brown; posteriorly obtuse. Shell, a dorsal, subcartilaginous scutcheon. *Mediterranean*. Pl. VII. Fig. 124. 3 Species.

2. *Dolabella* §.

Body crawling, oblong, contracted anteriorly, posteriorly dilated, and obliquely truncated by an inclined orbicular plane; borders of the mantle folded closely on the back. Four semi-tubular tentacula disposed in pairs. Operculum of the branchiæ containing a shell, covered by the mantle, and situated near the posterior part of the back. Anus dorsal near the branchiæ, in the middle of the orbicular facet.

Shell oblong, slightly arched, securiform; contracted, thick, callous, and nearly spiral on one side; wider, flatter, and thinner on the other.

Type. *Dolabella Rumphii*||.

Shell thick at the base, callous, subspiral; dilated at the upper part, thin, wedge-shaped. *Indian Ocean*. Pl. VII. Fig. 125. 2 Species.

* *Απλυσία*, a sponge which cannot be cleaned.

† Their form is similar to that of a hare's ear.

‡ Causing the hair to fall off—an effect attributed to a fetid whitish mucus, which exudes when the animal is touched. It excites nausea, and even vomiting.

§ A little axe, or hatchet.

|| Of Rumphius.

7th Family.

LIMACIANA. (5 Genera.)

Branchiæ resembling a vascular net-work, extended over the side of an appropriate cavity, the aperture of which the animal contracts or dilates at pleasure. They breathe only free air.

This family is very remarkable, the individuals which compose it being the only gasteropoda that breathe nothing but free air, although their respiratory organ is truly branchial. Hence, Lamarck proposes to call them *pneumobranchial*. They are quite, or very nearly, naked. Their body is long, creeping on an attached ventral disk, and bordered at the sides by an, often very short, mantle. They live in the neighbourhood of water, or in cool, damp places.

1. ONCHIDIUM.

This genus has no shell.

2. PARMACELLA.

Body creeping, oblong, inflated near the middle, where the scutellum is situated, terminated by a tail, compressed at the sides, acute above. Scutcheon oval, fleshy, adhering to the posterior part, anteriorly free, containing a shell, and notched in the middle of its right border. Orifice for respiration, and anus under the fissure in the scutcheon. Four tentacula; the two posterior the largest. Orifice for generation between the two tentacula, on the right side.

The Parmacella is a land animal, nearly allied to the limax, but distinguished from it by the anterior half of its scutcheon not being attached to the body. In each genus the scutcheon envelopes a solid, cretaceous body, which, in the parmacella, has the true form of a shell, whilst, in the limax, it is the mere element of one.

Type.

Parmacella caliculata *.

* *Cup-shaped*.—"Shell small, like a very flat bowl of a spoon, with a very short papilliform spire, contracted at its base, the aperture of its spire very small, but the outer lip very much spread out, and rather irregular"—"covered on the outside with a light-brown, thin, horny epidermis." The specific name and description of the Parmacella, which we have given as our type, is taken from Mr. G. B. Sowerby. (*Genera of Recent and Fossil Shells*.) The shell, from which our figure is taken, was furnished us by the kindness of Mr. Henry Stutchbury. Lamarck gives but one species, *P. Oli-*

3. *Limax* *.

Body oblong, naked, creeping, convex above, furnished anteriorly with a coriaceous, subrugose shield; below, with a flat longitudinal disk. Four retractile tentacula; the two posterior largest, with eyes at the summit. Branchial cavity under the shield, at the anterior part of the body. Orifice for respiration, and anus, at the right side of the shield; that for generation in front, between the two tentacula on the right.

The limax is a land animal; its skin is more or less rugose and sulcated externally. It has much analogy with the helix and bulimus, from which it differs principally in having no true shell, and by its shield, and other essential peculiarities. It creeps slowly, using its tentacula to feel the bodies that lie in its way, and which it projects and retracts, in the same manner that one turns the finger of a glove inside out. The animal is hermaphrodite and herbivorous, and frequents shady, damp places.

Type.

Limax rufus †. (Idem. Linn.)

Body longitudinally sulcated, reddish above, white underneath. *Infests gardens, &c.* Pl. VII. Fig. 127. 4 Species.

4. TESTACELLA.

Body creeping, elongated, limaciform, furnished with a shell at the posterior extremity. Four tentacula, the two largest with eyes at the summit. Orifice for respiration, and anus at the posterior extremity; that for generation under the largest tentaculum, on the right side.

Shell very small, external, subauriform; apex slightly spiral; aperture very large, oval, obliquely effuse; left margin involute.

The testacella is chiefly distinguished from the limax by the very small shell which covers the posterior extremity of the animal. It is, however, less allied to the limax than is the parmacella, with respect to the branchial cavity, and the posi-

rieri, and no specific description of the shell. Mr. Sowerby has adopted the name *calyculata*, "on account of a little testaceous ridge, which surrounds the aperture of the spire, forming a little cup." Pl. VII. Fig. 126.

* A slug.

† Reddish.

tion of the anus. The testacella is seldom met with alive, living almost constantly buried in the ground, where it preys on earth-worms.

One Species. *Testacella haliotidea* *.

No farther description. *South of France*. Pl. VII. Fig. 128.

5. VITRINA †.

Body creeping, elongate, limaciform, greatest part straight; hinder part separate from the foot, spiral, and enveloped in a shell. Several posterior appendages of the mantle spread over the shell, apparently for the purpose of cleaning it, and partly cover it. Four tentacula, the two anterior very short. Orifice for respiration, and anus, very far back, on the right side.

Shell small, very thin, depressed, terminated above by a short spire; last whorl very large. Aperture large, rounded-oval; left margin arched, slightly involute.

The *Vitrina* is small, and frequents cool, shady places.

One Species. *Vitrina pellucida* ‡.

No further description. *France*. Pl. VII. Fig. 129.

Third Order.

TRACHELIPODA.

Body spiral at the posterior part, which is separated from the foot, and always enveloped in the shell. Foot free, flattened, attached to the inferior base of the neck, or the anterior part of the body, and serves for creeping. Shell spirivalve, ensheathing.

The trachelipoda differ from the gasteropoda, by the posterior portion of the body being spirally convolute, and by the greater part of the foot being free, and only attached to the inferior base of the neck, or fore-part of the body. The spiral portion of the body never projects beyond the shell, its natural conformation not allowing it to extend itself in a straight line.

All the trachelipoda are conchiferous; their shell, generally external, is always more or less spiral.

The genera and species of this order are much more nume-

* Like a *haliotis*.

† From *vitrum*, glass.

‡ Transparent.

rous and diversified than those of the gasteropoda. The greater part of them inhabit the sea, some live in fresh water, and others on land. The shell of the latter is not at all, or only very slightly, pearly, and generally has no other external projections than the striæ of growth.

Lamarck divides the trachelipoda into two sections.

SECTION I.

TRACHELIPODA, without any Siphon. (Phytiphaga *.)

No projecting siphon; animal generally breathes by a hole. The greater part feed on vegetables, and are furnished with jaws.

Aperture of the shell entire; base without any ascending dorsal notch, or canal.

This section contains ten families.

1st Family.

COLIMACEA. (11 Genera.)

Breathe air; some furnished with an operculum, others not; tentacula cylindrical.

Shell spirivalve; no external projecting parts, except the striæ of growth; right margin of the aperture often curved outwards.

All the colimacea are land animals; the first nine genera have four tentacula, the two last, only two.

1. HELIX †.

Shell orbicular, convex, or conoidal, sometimes globular; spire but little elevated. Aperture entire, transverse, very oblique, contiguous to the axis of the shell; margins disunited by the projection of the penultimate whorl.

The Helix is distinguished from the pupa, by the general form of the shell, which is never cylindrical, and by the borders of the aperture being disunited; from the bulimus, by the aperture being rather transverse than longitudinal, and its plane very oblique, and almost perpendicular to the axis of the spire; and from the planorbis, by the left margin of the aperture

* *Herbivorous.*

† *A spiral line.*

being contiguous to the axis of the shell, whereas, in that genus, it is very remote from it. Lastly, the right margin, in the adult helix, is reflected outwards, which it never is in aquatic shells. The *Helix* is readily known by the projection of the penultimate whorl into the aperture, whence Linnæus described it, "*aperturâ intus lunatâ; segmento circuli dempto.*"

The animal has great resemblance to the limax.

The species of this genus are almost innumerable—Lamarck describes only those in his own collection.

Type. *Helix gigantea* *. (*Helix cornu militaire*. Linn.)

Shell orbicular-convex, imperforate, solid, white; epidermis red-brown; whorls transversely striated, aperture wide; lip white within; margin reflected. *Germany*. Pl. VII. Fig. 130. 107 species.

2. CAROCOLLA.

Shell orbicular, more or less convex, or conoidal, on the upper part, with a sharp, angular periphery. Aperture transverse, contiguous to the axis of the shell; right lip subangular, often toothed on the lower part.

The sharp edge of the last whorl, their being always orbicular, and sometimes considerably depressed, are the principal characteristics of the shells of this genus.

Type. *Carocolla acutissima* †.

Shell discoidal, convex on both sides, imperforate; periphery compressed and very acute; tawny; striæ small, oblique, very minutely granular; margin reflected, bidentate at the lower part. *Jamaica*. Pl. VII. Fig. 131.—18 Species.

3. ANOSTOMA †.

Shell orbicular, spire convex and obtuse. Aperture rounded, toothed within, ringent, turned upwards; margin of the right lip reflected.

The singular position of the aperture, directed upwards, towards the spire of the shell, is the characteristic of this genus, and peculiar to it.

* *Gigantic*. Lamarck's second species—his type is *H. vesicalis*.

† *Very acute*.

‡ From *ανω*, upwards, and *στόμα*, a mouth.

Type. *Anostoma depressum**. (*Helix ringens*. Linn.)

Shell suborbicular, convex on both sides, somewhat depressed, obtusely carinate, imperforate, smooth, whitish; a circular red line on the upper part; aperture with five teeth; lip very much reflected. *India*. Pl. VII. Fig. 132.—2 Species.

4. HELICINA.

Shell subglobular, no umbilicus. Aperture entire, semi-oval. Columella callous, transverse, rather flattened, with a sharp edge forming an angle at the lower base of the right lip. Operculum horny.

The *Helicinae* resemble small *neritæ*, but the latter are sea shells. They are distinguished from the *helices* by their transverse columella, which is callous, depressed, and thin at the lower part. They are land shells, and inhabit warm climates.

Type. *Helicina neritella*.

Shell ventricose, globular-conoidal; smooth, white; margin reflected. *Antilles*. Pl. VII. Fig. 133.—4 Species.

5. PUPA †.

Shell cylindrical, generally thick. Aperture irregular, semi-oval, rounded, and subangular at the lower part; margins nearly equal, reflected outwards, and disunited above by an interposed columellar lamina.

Type. *Pupa mumia* ‡.

Shell cylindrical, attenuated, obtuse, thick, white; furrows of the whorls longitudinal, oblique; aperture red-brown, biplicate; margin reflected. *Antilles*. Pl. VII. Fig. 134.—27 Species.

6. CLAUSILIA §.

Shell generally fusiform, slender, summit rather obtuse. Aperture irregular, rounded-oval; margins united throughout, free, reflected outwards.

The essential character of the *clausilia*, is that the two borders of the aperture are completely united, free in their contour, and reflected outwards.

* *Depressed*.

† *A puppet*.

‡ *A mummy*.

§ From *claudo*, to shut, because the aperture of the shell is closed by a little apparatus, consisting of two small valves, situated in the penultimate whorl, and not visible externally.

Type. *Clausilia torticollis* *.

Shell reverse, cylindrical, truncated; striæ straight, ferruginous-red; neck narrow, angular, and arched; aperture without teeth. *Isle of Candy*. Pl. VII. Fig. 135.—12 Species.

7. BULIMUS †.

Shell oval, oblong, or turritid; aperture entire, longitudinal; margins very unequal, disunited at the upper part. Columella straight, smooth; no truncation or notch at the base.

The last whorl of the spire of the bulimus is larger than the penultimate; the shell is never orbicular, like the helix; and it differs from the pupa, by the great inequality of the two margins of the aperture, the right of which is sometimes considerably thickened.

Type. *Bulimus hæmastomus* ‡. (*Helix oblonga*. Gmel.)

Shell ovate-oblong, ventricose, subperforate, longitudinally striated, whitish-yellow; lip and columella purple. *Guyana*. Pl. VII. Fig. 136.—34 Species.

8. ACHATINA.

Shell oval or oblong; aperture entire, longitudinal; right margin sharp, never reflected. Columella smooth, truncated at the base.

This genus is well distinguished from the preceding, by the right margin never being reflected, and by wanting that on the left; the columella being always naked, very smooth, and truncated at the base.

Lamarck subdivides the genus into, 1. Those shells which have the last whorl ventricose, and not depressed,—12 Species; and, 2. Those with it depressed, and attenuated towards the base,—7 Species.

Type. *Achatina perdix* §. (*Bulla achatina*. Linn.)

Shell very large, ovate-oblong, ventricose, decussated, white, apex rosy; light red, wavy, longitudinal streaks; columella violet-purple; interior of the lip white. *Antilles*. Pl. VII. Fig. 137.—In all, 19 Species.

* Wry-necked.

† Βελιμος, insatiable hunger. What title this genus has to so strange a name, we know not.

‡ Bloody-mouth. Lamarck's second species. His type is *B. oratus*.

§ A partridge.

9. SUCCINEA *.

Shell oval, or ovate-conical. Aperture large, entire, longitudinal; right margin sharp, not reflected; united at the lower part to a smooth, attenuated, acute columella. No operculum.

The Succineæ live habitually on land, in the neighbourhood of water, which they occasionally frequent. They are distinguished from the bulimi, by the right margin never being reflected, and from the lymnææ, by their columella being free from folds.

Type. *Succinea amphibia* †. (*Helix putris*. Linn.)

Shell ovate-oblong, very thin, transparent, yellowish; spire short; aperture dilated, at the lower part, subvertical. *France*, Pl. VII. Fig. 138.—3 Species.

10. Auricula ‡.

Shell suboval, or oval oblong. Aperture longitudinal, very entire at the base, contracted at the upper part, where the margins are disunited. One or more folds on the columella. Lip sometimes reflected outwards, sometimes simple and sharp.

Land-shells, and distinguished from bulimus, by the folds on the columella. The genus is subdivided into (1,) those with the right margin reflected outwards—10 species; and (2) those with the margin simple and sharp—4 species.

Type. *Auricula Midæ* §. (*Voluta auris Midæ*. Linn.)

Shell ovate-oblong, very thick, decussately striated, granular above, white; chestnut brown epidermis; spire short, conoidal; middle of the aperture contracted; columella biplicate.

East Indies. Pl. VII. Fig. 139.—14 Species.

11. Cyclostoma ||.

Shell of variable form; sometimes subdiscoidal, sometimes conical, or turritid, or subcylindrical. Whorls of the spire cylindrical. Aperture round, regular; margins circularly united, open, or reflected by age. Operculum horny.

Land-shells, never pearly, generally thin, and without squamæ or tubercles on the outside, distinguished from the paludinæ

* Amber-coloured.
§ Midas's.

† Amphibious.
|| κυκλος, a circle, and στομα, a mouth.

‡ A little ear.

by the outward reflection of the margin of the adult shell, whilst in that genus it is always sharp, and not reflected; from the pupa, by the regularity of the aperture, which is never angular.

Type. *Cyclostoma volvulus* *.

Shell trochiform, deeply umbilicate; transversely striated; variegated with brownish white and red; spire acuminate; aperture white, or brownish; margin reflected. Pl. VII. Fig. 140. 28 Species, the two last doubtful.

2d Family.

LYMNÆANA. (3 Genera.)

Amphibious trachelipoda, generally provided with an operculum, and two flattened tentacula without eyes at their summit. They live in fresh water, and come to the surface to breathe air.

Shell spirivalve, generally smooth externally; right margin of the aperture always acute and not reflected.

1. Planorbis †.

Shell discoidal, spire flattened, scarcely projecting; all the whorls visible on both sides. Aperture oblong, lunate, very distant from the axis of the shell; margin not reflected. No operculum.

Fresh water shells, generally thin, brittle, diaphanous; the whorls of some are subcylindrical, of others carinate or angular. Aperture sublongitudinal, with an internal projection formed by the penultimate whorl.

Type. *Planorbis corneus* ‡. (*Helix cornea*. Linn.)

Shell opaque, flat depressed above, broadly umbilicate below; horn or chestnut brown; whorls transversely striated.

France. Pl. VII. Fig. 141. 12 Species.

2. Physa §.

Shell convolute, oval or oblong, spire projecting. Aperture

* *A twisting.*

† *From planus, flat, and orbis, an orb.*

‡ *Horny.* Lamarck's second species. His type, *P. cornu arietis*, Mr. Sowerby considers as an *Ampullaria*.

§ Mr. Sowerby is of opinion, that there is not sufficient ground for forming distinct genera, of this and the following shell. He has therefore struck out physa, and placed it with the genus lymnæa. (Genera of recent and fossil shells. No. 8.)

longitudinal, contracted above. Columella twisted. Right margin very thin, acute, partly projecting beyond the plane of the aperture. No operculum.

The physæ are fresh water shells, thin, brittle and generally reverse. They are distinguished from the bullæ by their projecting spire, and from the lymnæa, which they otherwise much resemble, by the aperture not being dilated, the right margin projecting a little above its plane.

Type. *Physa fontinalis* *. (*Bulla fontinalis*. Linn.)

Shell reverse, oval, diaphanous, smooth, horn-brown, (luteco-cornéa;) spire very short, sub-acute. Pl. VII. Fig. 142.—4 Species.

3. Lymnæa.

Shell oblong, sometimes turrit, often rather ventricose below, generally thin; spire projecting. Aperture entire longitudinal. Right margin acute, its lower part, turning to the left and ascending, passes over the columella towards the aperture, forming a very oblique fold. No operculum.

The very oblique fold on the columella, distinguishes the lymnæa from the bulimus, and the regular uninterrupted plane of the aperture, from the physa.

Type. *Lymnæa stagnalis* †. (*Helix stagnalis*. Linn.)

Shell acute-ovate, ventricose, thin, transparent, longitudinally substriated; reddish grey; last whorl subangular above; spire conico-subulate; aperture large; lip broad.

France. Pl. VII. Fig. 143. 12 Species.

3rd Family.

MELANIANA. (3 Genera.)

Operculated, fluviatile trachelipoda; breathe only water. Two tentacula. Operculum horny.

Borders of the aperture of the shell disunited; right margin always acute.

Most of the shells of this family are exotic, and are covered with a brownish green or blackish epidermis.

* Of the springs. Lamarck's second species; his type is *P. castanea*.

† Of stagnant waters. The first species, *L. columnaris*, Lamarck has removed to the genus *Achatina*—See erratum. Vol. vii. p. 678.

1. *Melania* *.

Shell turritid. Aperture entire, oval or oblong, effuse at the base. Columella smooth, incurved. Operculum horny.

Type. *Melania truncata* †.

Shell turritid, apex truncated, solid, blackish brown; ribs longitudinal, the superior most projecting, decussated by numerous transverse striæ; whorls plano-convex..

Guiana. Pl. VII. Fig. 144. 16 Species.

2. *Melanopsis* ‡.

Shell turritid, aperture entire, oblong-oval. Columella callous above, truncated at the base, separated from the right lip by a sinus. An operculum.

The callus on the upper part of the columella distinguishes the *Melanopsis* from the *Melania*, as well as its being truncated at its base like the *achatina*, which is never the case with the *Melania*.

Type. *Melanopsis lævigata* §.

Shell ovate-conical, smooth, chestnut colour; six whorls, rather flattened, convex at the spire; the last whorl towards the spire the longest.

Archipelago. Pl. VII. Fig. 145. 2 species.

3. *Pirena* ||.

Shell turritid; aperture longitudinal; right lip acute, with a sinus at its base, and another at the summit. Base of the columella curved towards the right margin. Operculum horny.

Principally distinguished from *Melanopsis* by having no callus on the columella, and from that genus and *melania* by a sinus both at the base and summit of the right lip.

Type. *Pirena terebralis* ¶. (*Strombus ater*, Linn.)

Shell subulate-turritid, smooth, black; whorls flattened; aperture white.

India. Pl. VII. Fig. 146. 4 species.

* From *μελας*, black.

† Truncated—2nd Species. Lamarck's type is *M. asperata*.

‡ From *μελας*, black, and *οψις*, a face.

§ Smooth—2nd Species. Lamarck's type is *M. costata*.

|| From *σπίρα*, the point of a sword?

¶ From *terebro*, to pierce.

4th Family.

PERISTOMIANA. (3 genera.)

Operculated, fluviatile trachelipoda; breathe only water. Shell operculated, conoidal, or subdiscoidal; borders of the aperture united.

The shells of this family all belong to fresh water, and have a thin greenish or brown epidermis. They are distinguished from the three preceding genera by the margin of the aperture being united.

1. Valvata*.

Shell discoidal or conoidal; whorls cylindrical; spiral cavity complete, or not deranged by the penultimate whorl; aperture rotundate; margins united, acute; operculum orbicular.

Type. *Valvata piscinalis*†.

Shell globose-conoidal, subtrochiform, perforate, whitish; about five whorls; apex of the spire obtuse.

France. Pl. VII. Fig. 147. 4 species are known, but Lamarck only describes the above.

2. Paludina‡.

Shell conoidal, whorls rounded or convex, modifying the spiral cavity; aperture rounded oval, longitudinal, angular at the summit; the two margins united, acute, never curved outwards; operculum orbicular, horny.

The paludinae generally live in fresh water, though some inhabit brackish, and even salt, water. They are distinguished from the valvatae by the somewhat elongated and angular form of the aperture.

Type. *Paludina vivipara*§. (*Helix vivipara*, Linn.)

Shell ventricose-conoidal, thin, diaphanous, very delicately striated longitudinally, brownish green; obsolete, brown-red, transverse bands; five whorls, rotundate, turgid; sutures very marked.

France. Pl. VII. Fig. 148. 7 species.

* *Valva*, a folding door, or valve. † Of the pools.
‡ From *palus*, a marsh. § *Viviporous*

3. *Ampullaria* *.

Shell globular, ventricose, umbilicate at the base ; no callus on the left lip ; aperture entire, longitudinal ; margins united ; right margin not reflected ; an operculum.

The last whorl is, at least, four times as large as the penultimate. The columellar lip projects, and is reflected over the umbilicus, forming a half funnel, but no callus. The shells of this genus are generally large.

Type. *Ampullaria Guyanensis* †.

Shell ventricose-globular, solid, longitudinally, and unequally striated ; epidermis brown ; six whorls ; last whorl the largest ; aperture orange-coloured.

Rivers of Guiana. Pl. VII. Fig. 149. 11 species.

5th Family.

NERITACEA. (4 genera.)

Operculated trachelipoda ; some inhabit fresh water, others are marine.

Shell fresh-water or marine, semi-globular or flattened oval ; no columella ; left margin of the aperture acute, transverse, and resembling a half partition, with which the operculum articulates.

1. *Navicella* ‡.

Shell elliptical or oblong, convex above ; summit straight, depressed to the margin ; under side concave. Left margin flattened, acute, narrow, toothless, transverse § ; operculum solid, flat, with an acute lateral tooth.

Exotic, fresh-water shells ; distinguished from nerita and neritina by the summit not being spirally convolute. The transverse, left lip, never covers half the cavity.

Type. *Navicella tessellata* ||.

Shell oblong elliptical, thin, diaphanous, tessellated with yellowish and brown oblong square spots ; vertex maginal, not projecting.

Rivers of India. Pl. VIII. Fig. 150. 3 species.

* *Ampulla*, a wide-bellied bottle. † *Of Guiana.* ‡ *Pro navicula*, a little boat.

§ The transverse position of the flattened left lip gives the shell, when held with the concave side upwards, the appearance of a little boat with a half-deck. || *Tessellated*—3rd Species. Lamarck's type is *N. elliptica*.

Fig 150



150 a



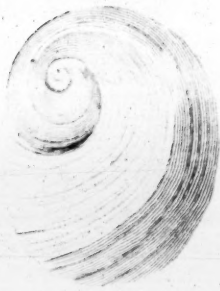
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156 a



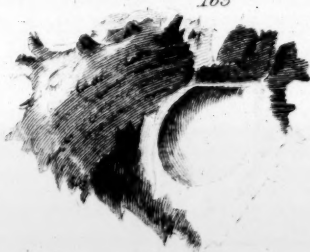
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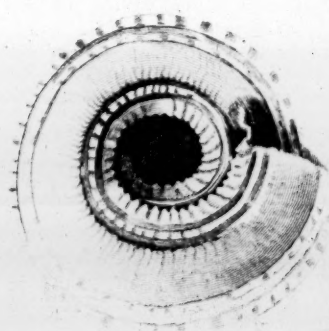
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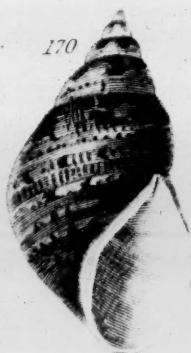
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J. Barre sculp.

2. *Neritina* *.

Shell thin, semi-globular or oval, flattened on the lower part; no umbilicus. Aperture semi-circular; left lip flattened, acute; no teeth, nor crenations on the internal face of the right margin. Operculum furnished with a projecting apophysis, or lateral tooth, on one side.

Fresh-water shells, generally thin, and smooth externally.

Type. *Neritina pulligera* †. (*Nerita pulligera*. Linn.)

Shell ovate, delicately striated, blackish brown, dotted with small round young shells, which adhere to it; lip dilated, thin, white internally; margin acute; lower border yellowish; lip crenate.

India. Pl. VIII. Fig. 151. 21 species.

3. *Nerita* ‡.

Shell solid, semi-globular, flattened on the lower part; no umbilicus. Aperture entire, semi-circular; left lip flattened, septiform, acute, often crenate; internal face of the right lip crenate. Operculum furnished with an apophysis.

All sea-shells, solid, rather thick, and agreeably varied in colour. The spire is but little elevated above the last whorl. The operculum is crescent-shaped, horny, or calcareous, and exactly closes the aperture. When the animal comes out of the shell, the operculum falls back on the flat part of the columella, like a shutter. The *nerita* differs from *neritina* by the internal face of the right margin being crenate, and from *natica* by having no umbilicus.

Type. *Nerita exuvia* §. (*Idem*, Linn.)

Shell thick, white, spotted with black; ribs transverse, those on the back acute, rough-squamose, decussated by longitudinal striæ; interior of the lip crenate; upper part of the margin verrucose, and toothed.

Indian Ocean. Pl. VIII. Fig. 152. 17 species.

4. *Natica*.

Shell sub-globular, umbilicated; aperture entire, semi-

* Dim. of *Nerita*. † Bearing its young.

From νητις, the Greek name for a kind of sea shell,—from νηω, to swim, because it swims on the sea.

§ Exuvia, spoils.

circular; left lip oblique, not crenate, callous; form of the umbilicus modified by the callus, and sometimes covered by it; right lip acute, always smooth internally; operculum generally solid, calcareous.

Sea-shells, distinct from *nerita*, by the umbilicus, and by the columellar margin not being crenate, but smooth, and callous, and by the smoothness of the interior of the right lip.

Type. *Nerita glaucina**. (Idem, Linn.)

Shell suborbicular, inflated, thick, smooth, whitish yellow, and cœrulescent; spire short, oblique; callus subdivided, partly covering the umbilicus, red.

Bay of Campeachy. Pl. VIII. Fig. 153.—31 species.

6th Family.

IANTHINEA †. (1 Genus.)

Shell inflated, conoidal, thin, transparent. Aperture triangular. Columella straight, projecting beyond the base of the right lip; a sinus in the middle of the latter. No operculum.

Sea shells, always found at the surface of the water, of a violet colour throughout, very thin, transparent, and brittle.

Type. *Ianthina communis* ‡. (Helix *Ianthina*. Linn.)

Shell ventricose-conoidal, longitudinally sub-rugose, transversely delicately striated, violet; last whorl large, angular; apex of the spire rather obtuse. *Mediterranean*. Pl. VIII. Fig. 154.—2 Species.

7th Family.

MACROSTOMIANA §. (4 Genera.)

Shell auriform, aperture extremely dilated, margins disunited. No columella, nor operculum.

1. SIGARETUS.

Shell sub-auriform, nearly orbicular; left margin short, spiral. Aperture entire, very dilated, longitudinal; margins disunited.

The shell of the *Sigaretus* is concealed under the mantle of the animal.

* Bluish, or sea-green colour.

‡ Common.

† From *Ianthum*, a violet.

§ From *μακρος*, large, and *στομα*, a mouth.

Type. *Sigaretus haliotoideus* *. (*Helix haliotoidea*. Linn.)

Shell auriform, back depressed, convex; undulately striated transversely, whitish; spire very obtuse; aperture very dilate; umbilicus covered. *Atlantic Ocean*. Pl. VIII. Fig. 155.—4 Species.

2. STOMATELLA †.

Shell orbicular or oblong, auriform, imperforate. Aperture entire, large, longitudinal; right margin effuse, dilated, open.

Distinguished from stomatia, by not having the transverse rib of that shell, nor the right lip so much elevated; and from the haliotis, by wanting the foramina, or row of perforations, which mark that genus. They are all sea shells, pearly externally.

Type. *Stomatella sulcifera* ‡.

Shell sub-orbicular, convex, thin, transversely sulcated, very delicately striated longitudinally, reddish-grey; furrows rather rough; spire slightly projecting. *New Holland*. Pl. VIII. Fig. 156.—5 Species.

3. STOMATIA §.

Shell auriform, imperforate; spire prominent. Aperture entire, large, longitudinal; right and columella lip equally elevated. Dorsal rib transverse, tuberculated.

Distinguished from haliotis by the dorsal rib being imperforate. Sea shells, sometimes very pearly.

Type. *Stomatia phymotis* ||. (*Haliotis imperforata*. Chemn.)

Shell resembling a haliotis, ovate-oblong, back convex, striated, nodular, silvery; spire minute, contorted; lip thin, acute. *Indian Ocean*. Pl. VIII. Fig. 157.—2 Species.

4. HALIOTIS ¶.

Shell auriform, usually flattened; spire very short, sometimes depressed, sublateral. Aperture very large, longitudinal, and, in the perfect shell, entire. Disc perforated with holes, dis-

* Like a haliotis.

† Dim. from *στόμα*, a mouth.

‡ Furrowed. 3d Species.—Lamarck's type is *S. imbricata*.

§ From the same Greek word as the last genus.

|| From *φύμα*, a mushroom, or the knotty excrescence of a tree, and *οὖς*, an ear.

¶ From *ἅλς*, the sea, and *οὖς*, an ear.

posed in a line parallel to, and near the left lip; the last hole incomplete, forming only a notch. No operculum.

Type. *Haliotis Iris* *. (Idem. *Gmel.*)

Shell rounded-oblong, very large, thin, rugose-plicate, prettily varied with green, red, and blue; spire sub-prominent, obtuse; left lip elevated. *New Zealand*. Pl. VIII. Fig. 158.—15 Species.

8th Family.

PLICACEA †. (2 Genera.)

Aperture of the shell not dilated; columella plaited.

All sea shells, distinct from the Auriculæ, which are land shells, by their general form and projecting spire; and from the Volutæ, Mitræ, &c., by having no notch at the base of the aperture.

1. TORNATELLA ‡.

Shell convolute, ovate-cylindrical, generally striated transversely; no epidermis. Aperture oblong, entire; right lip acute; one or more plaits, usually thick and obtuse, on the columella. Spire prominent.

Type. *Tornatella flammea* §. (*Voluta flammea*. *Linn.*)

Shell oval, ventricose, transversely striated, white, with red, wavy, longitudinal markings; spire conoidal, columella with one fold. Pl. VIII. Fig. 159.—6 Species.

2. PYRAMIDELLA ¶.

Shell turrited, no epidermis. Aperture entire, semi-oval; outer lip acute. Columella straight, projecting at the base, subperforate; three transverse folds on the columella

Type. *Pyramidella dolabrata* ¶. (*Trochus dolabratus*. *Linn.*)

Shell conico-turrited, perforate, smooth, white, with surrounding yellowish lines; columella recurved; interior of the lip toothed, and sulcated. *South America*. Pl. VIII. Fig. 160. 5 Species.

* A rainbow. 2d species.—Lamarck's type is *H. midæ*.

† From *plico*, to fold.

‡ From *torno*, to turn in a lathe.

§ Yellow, or flame colour.

¶ From *pyramis*, a pyramid.

¶ Cut with an axe. 2d Species—Lamarck's type is *P. terebellum*.

9th Family.

SCALARIANA. (3 Genera.)

No plaits on the columella; margins of the aperture circularly united. All sea shells.

The shells of the Scalariana have a tendency to form a loose spire, so that the whorls are often disunited, and do not rest one on another.

1. VERMETUS *.

Shell thin, tubular, loose spiral; spire adhering by the apex. Aperture orbicular, margins united. Operculum cartilaginous.

This shell has great resemblance to a *serpula*; its animal, however, is not one of the *annulata*, but a true *molluscum*, and properly placed with the *trachelipoda*. (See Adanson's *Senegal*, Pl. xi. fig. 1. *Vermetus*.) The *vermeti* are commonly found in groups, twisted together.

One Species. *Vermetus lumbricalis* †.

Shell attached by the apex of the spire, extended anteriorly into an ascending tube, thin, transparent, reddish yellow. *Senegal*. Pl. VIII. Fig. 161.

2. SCALARIA †.

Shell sub-turritid, spire more or less elongated, last whorl rather larger than the penultimate; ribs longitudinal, elevated, interrupted, sub-acute. Aperture nearly round; margins circularly united, and terminated by a thin curved varix.

Type. *Scalaria pretiosa* §. (*Turbo scalaris*, Linn.)

Shell conical, umbilicated, loose, spiral, pale yellow; ribs white; whorls disunited, smooth, the last ventricose. *Indian Seas*. Pl. VIII. Fig. 162.—7 recent species, and 3 fossil.

3. DELPHINULA ||.

Shell subdiscoidal, or conical, umbilicated, solid, internally pearly, whorls of the spire rough, or angular. Aperture entire, round, sometimes triangular; margins united, generally fringed or varicose.

Distinguished from *turbo*, by the united margins.

* From *vermis*, a worm.

† From *scala*, a flight of steps.

|| Dim. from *delphinus*, a dolphin.

† From *lumbricus*, an earth-worm.

§ Costly, precious.

Type. *Delphinula laciniata* *. (Turbo delphinus. Linn.)

Shell subdiscoidal, thick, transversely rudely sulcated; furnished with very large, curved, ramose, jagged appendages; variegated with red and brown; spire obtuse. *Indian Ocean*. Pl. VIII. Fig. 163.—3 recent species, and 7 fossil.

10th Family.

TURBINACEA †. (8 Genera.)

Shell turritid or conoidal; aperture round or oblong, not dilated; margins disunited.

All sea-shells, and appear to be operculated. When placed on their base, the axis is always more or less inclined, never vertical.

1. Solarium ‡.

Shell orbicular, depressed conical; umbilicus open, always crenate or toothed on the internal margins of the whorls. Aperture subquadrangular; no columella.

The crenate umbilicus of the solarium sufficiently distinguishes it from the trochus and planorbis.

Type. *Solarium perspectivum* §. (Trochus perspectivus. Linn.)

Shell orbicular, conoidal, longitudinally striated, whitish yellow; bands articulated with white and brown, or chestnut colour near the sutures; crenations of the umbilicus very small. *Indian Ocean*. Pl. VIII. Fig. 164. 7 recent species, and 8 fossil.

2. Rotella ¶.

Shell orbicular, shining, no epidermis; spire very short, subconoidal; lower face convex, callous. Aperture semi-circular.

Distinguished from trochus by the lower surface being remarkably callous, and from the helicina by the callous not being confined to the columellar lip, but extending over a large portion of the lower side of the shell.

Type. *Rotella lineolata* ¶. (Trochus vestiarius. Linn.)

* Jagged.

‡ A sun dial.

¶ A very small wheel.

† From turbinatus, fashioned like a top?

§ Perspective.

¶ Marked with little lines.

Shell orbicular, convex, conoidal, very smooth, pale flesh-colour; numerous undulated, brown, longitudinal lines; whorls contiguous; lower face white. *Mediterranean*. Pl. VIII. Fig. 165. 5 Species.

3. *Trochus* *.

Shell conical, spire elevated, sometimes rather depressed; periphery more or less angular, often thin and acute. Aperture depressed transversely; margins disunited at the upper part. Columella arched, more or less prominent at the base. An operculum.

Many trochi have a brilliant pearly surface, and several have longitudinal ribs, which, we believe, are never found in the turbo.

Type. *Trochus imperialis*†. (Idem. *Gmel.*)

Shell orbicular-conoidal, apex obtuse, brown inclining to violet above, white below; transverse furrows, imbricate-squamose; whorls convex, turgid, radiated with a squamose margin; squamæ complicate; umbilicus funnel-shaped.—*South Seas*. Pl. VIII. Fig. 166. 69 Species.

4. *Monodonta* ‡.

Shell oval or conoidal. Aperture entire, round; margins disunited at the upper part. Columella arched, truncated at the base. Operculum orbicular, thin, horny.

Distinguished from trochus chiefly by the more circular form of the mouth; from turbo by the columella being truncated at the base, and forming a characteristic dentiform projection in the aperture.

Type. *Monodonta pagodus*§. (*Turbo pagodus*. *Linn.*)

Shell obliquely conical, imperforate, tubercular, ribbed longitudinally, transversely furrowed, brownish grey; ribs terminating in long, compressed tubercles beyond the margin of the spires; lower face white, with concentric furrows, pimpled. *Indian Ocean*. Pl. VIII. Fig. 167. 25 Species.

5. *Turbo* ||.

Shell conoidal, or subturritid; periphery never compressed;

* A child's top.

‡ From *μονος* one, and *οδης* a tooth.

† Imperial.

§ Pagoda.

|| A wreath.

whorls always round. Aperture entire, round, not disturbed by the penultimate whorl; lips disunited at the upper part, columella arched, flattened, not truncated at the base. An operculum.

The axis of the shell is generally more inclined than that of the trochus.

Type. *Turbo marmoratus**. (Idem. *Linn.*)

Shell subovate, very ventricose, imperforate, smooth, marbled, or subfasciated with green, white and brown; last whorl transversely nodular, in three directions; upper nodules largest; base of the lip expanded, caudate; mouth silvery. *Indian Ocean*. Pl. VIII. Fig. 168. 34 Species.

6. *Planaxis* †.

Shell oval-conical, solid. Aperture oval, sublongitudinal. Columella flattened, truncated at the base, separated from the right lip by a narrow sinus. Interior face of the right lip furrowed or striped, with a callus running under its summit.

The planaxis is distinguished from phasianella by the truncation of the columella; it is transversely furrowed externally, and generally of small size.

Type. *Planaxis sulcata*‡.

Shell ovate-conical, imperforate, transversely sulcated, white, spotted with black; spots subquadrate; margin of the lip crenate; internally striated. *Antilles*. Pl. VIII. Fig. 169. 2 Species.

7. *Phasianella* §.

Shell oval or conical, solid; the last whorl much larger than any of the others. Aperture entire, oval, longitudinal, inclined obliquely towards the base of the columella, round at the lower part, and contracted at the upper; lips disunited at the upper part; right margin acute, not reflected. Columella smooth, compressed, attenuated at the base. Operculum calcareous or horny.

Generally smooth, brilliant shells, without any epidermis, and ornamented with various lively colours.

* Marbled.

† Flattened axis?

‡ Furrowed.

§ Dim. from *Phasianus*, a pheasant.

Type. *Phasianella bulimoides**. (*Buccinum australe*. Gmel.)

Shell oblong-conical, rather thin, smooth, palish yellow, transversely fasciated; fasciæ numerous, variously variegated and spotted; apex of the spire acute. *New Holland*. Pl. VIII. Fig. 170. 10 Species.

8. *Turritella*†.

Shell turrited, not pearly. Aperture rounded, entire, margins disunited at the upper part, not reflected outwards; a sinus in the right lip. Operculum orbicular, horny.

Distinguished from turbo by the general form of the shell, and by the sinus on the right lip, a constant character. Most of the species are transversely carinated or striated, but none of them have vertical ribs, varices, or tubercles.

Formerly all the turrited shells were called screw shells. Thus turritella, scalaria, cerithium, &c., were all confounded with the true screw shell, terebra.

Type. *Turritella duplicata*‡. (*Turbo duplicatus*. Linn.)

Shell turrited, thick, heavy, transversely sulcated and carinated, whitish yellow, apex reddish; whorls convex, carinated; the two middle carinæ most prominent. *Coast of Coromandel*. Pl. VIII. Fig. 171. 13 recent Species, and 2 fossil §.

SECTION II.

TRACHELIPODA with a projecting siphon. (Zoophaga||.)

The animals of this section breathe only water, which is conveyed to the branchiæ by the projecting siphon. They are all carnivorous, marine, without jaws; and have a retractile proboscis. Two tentacula on the head.

Shell spirivalve, ensheathing, aperture canaliculated or notched, or merely inclined at the base.

* Resembling a bulinus.

† Dim. from turris, a little tower.

‡ Doubled, because it is bi-carinated.

§ Desmarests has described a new genus, established by Freminville, which we shall add in this place. It has been called *Rissoa*; we give a figure of one species.

Shell univalve, oblong or turrited, generally furnished with prominent longitudinal ribs, aperture entire, oval, oblique; no canal at the base; no tooth, nor plait; margins united, or nearly united; right margin inflated, not reflected. No umbilicus. *Gulf of Genoa*. Fig. 172. (Vide *Nouveau Bulletin des Sciences*, or *Nouveau Dictionnaire d'Histoire Naturelle*.)

|| Carnivorus.

This section contains five families ; in the two first the canal at the base of the aperture is always manifest ; in the third it disappears, and the two last have only a notch, and a small, low, inclined margin.

1st Family.

CANALIFERA. (11 Genera.)

Shell with a canal, variable in length, at the base of the aperture, the right margin of which does not alter by age. An operculum.

This family is separated into two divisions.

1st Division.

No constant varix on the right lip.

1. *Cerithium* *.

Shell turrited. Aperture short, oblong, oblique, terminated at the base, by a short truncated or curved canal ; never notched. A slight channel at the upper extremity of the right lip. Operculum small, orbicular, horny.

The spire of the shell constitutes at least two thirds of its whole length ; the last whorl being but little larger than the preceding one, the shell has the form of an elongated pyramidal-cone ; surface generally striated or tubercular, and sometimes varicose.

A thorough knowledge of this numerous genus is very important to the modern geologist.

Type. *Cerithium palustre* †. (*Strombus palustris*. Linn.)

Shell turrited, thick, longitudinally plicate, transversely striated, brownish ; whorls tri-striated, the last with very numerous sulciform striæ ; lip sub-crenate.

East Indies. Pl. VIII. Fig. 173. 36 recent species, and 60 fossil.

2. *Pleurotoma* ‡.

Shell turrited, or fusiform, terminated at the lower part by a

* From *Cerites*, a gem of a waxen colour ?

† Of the marshes ; Lamarck's 2d genus ; his type is *C. giganteum*.

‡ From *πλευρα*, the side, and *τεμνω* to cut, denoting the characteristic fissure on the right lip.

straight canal, more or less elongated. A fissure or sinus in the upper part of the right lip. Operculum oblong, horny.

Type. *Pleurotoma Babylonica* *. (Murex Babylonius. Linn.)

Shell fusiform, turrited, transversely carinated, and banded, white; bands spotted with black, spots quadrangular; whorls convex; base rather long.

Indian Ocean. Pl. VIII. Fig. 174. 25 recent species, and 30 fossil.

3. *Turbinella* †.

Shell turbate, or subfusiform, channelled at the base; from three to five compressed, transverse folds on the columella.

Distinguished from *voluta*, by the canal at the base of the aperture; from *murex* by having no varices, and from *fasciolaria* by the direction of the folds on the columella.

Type. *Turbinella cornigera* ‡. (*Voluta turbinellus*. Linn.)

Shell ovate-turbinated, subtriangular, transversely sulcated, with white tubercles on every side; interstices of the tubercles black; upper part of the last whorl surmounted by thick elongated tubercles, trifurcate posteriorly, and near the base, muricated with other simple tubercles; spire very short, acuminate; columella quadriplicate.

Indian Ocean. Pl. VIII. Fig. 175. 23 Species.

4. *Cancellaria* §.

Shell oval or turrited. Aperture sub-canalicate at the base; canal very short or scarcely perceptible. Columella plaited; folds numerous or few, generally transverse; right lip sulcated internally.

Type. *Cancellaria reticulata* ||. (*Voluta reticulata*. Linn.)

Shell ovate, ventricose, perforate, thick, transversely rugose, reticulated with oblique longitudinal striæ, slightly marked with yellowish white, and red zones; whorls convex; sutures compressed; upper part of the columella smooth, lower portion triplicate.

South Atlantic Ocean. Pl. VIII. Fig. 176. 12 recent species, and 7 fossil.

* *Babylonian*. Lamarck's 17th species. His type is *P. imperialis*.

† *Dim. of Turbo*.

‡ *Horned*. Lamarck's 7th species; his type is *T. scolymus*.

§ *From cancelli, latice*?

|| *Reticulated*.

5. *Fasciolaria* *.

Shell subfusiform, channelled at the base, no varices; two or three very oblique folds on the columella, near the canal.

Distinguished from *fusus* by the folds on the columella, and from *turbinella* by their oblique direction.

Type. *Fasciolaria tulipa* †. (*Murex tulipa*. Linn.)

Shell fusiform, ventricose in the middle, smooth, reddish orange-coloured, or marbled with white and red; brown transverse lines at unequal distances; whorls very convex; sutures marginally fringed; base sulcated; lip internally white, striated.

Antilles. Pl. VIII. Fig. 177. 8 Species.

6. *Fusus* ‡.

Shell fusiform, or subfusiform, channelled at the base; ventricose in the middle, or lower part; no external varices; spire elevated and elongated; no fissure or sinus in the right lip. Columella smooth. Operculum horny.

Type. *Fusus colus* §. (*Murex colus*. Linn.)

Shell fusiform, narrow, transversely sulcated, white; apex and base red; belly small; whorls convex, nodular carinate in the middle; base slender, long; lip sulcated internally, margin toothed.

Indian Ocean. Pl. VIII. Fig. 178. 37 recent species, and 13 fossil.

7. *Pyrula*. ||

Shell subpyriform, channelled at the base, ventricose at the upper part; no external varices; spire short, sometimes flattened, columella smooth. No fissure on the right lip.

The *pyrula* differs widely from *fusus*, by its short spire, and by the remarkable inflation of the last whorl, being always at the upper part of the shell.

Type. *Pyrula canaliculata* ¶ (*Murex canaliculatus*. Linn.)

Shell pyriform, ventricose, thin, rather smooth, palish yellow; upper part of the whorls angular, with flattened tops; channels of the sutures distinct; angle of the upper whorls crenate; base rather long.

Canada. Pl. VIII. Fig. 179. 28 Species.

* From *fasciola*, a little band.

† A tulip.

‡ A spindle.

§ A distaff. Lamarck's third species; his type is *F. colosseus*.

|| Dim. from *pyrum*, a pear.

¶ Channelled.

ART. V. *On the native Country of the Wild Potato, with an Account of its Culture in the Garden of the Horticultural Society; and Observations on the Importance of obtaining improved Varieties of the cultivated Plant* *. By JOSEPH SABINE, Esq., F.R.S., &c.

THE possession of the plants of the *Native Wild Potato* has been long a desideratum, and from the great importance and extensive use of the cultivated root, the subject of course became an object of attention to the Horticultural Society. In my communications with the Society's correspondents on the other side of the Atlantic, this was pointed out as one of the most interesting objects to which their attention could be directed; and it is with no small satisfaction that I am able to state that our inquiries have been successful.

Great doubts have existed as to what parts of the new world the natural habitat of the *Solanum tuberosum* or Potato should be assigned; and the question is even now a matter of discussion among Botanists of the greatest eminence. The vegetable, in its cultivated state, was first known in this country as the Potato of Virginia; I conceive, however, there can be little doubt that the plants which Sir Walter Raleigh found in that colony, and transferred to Ireland, had been previously introduced there from some of the Spanish territories, in the more southern parts of that quarter of the globe; for had the potato been a native of any district, now forming part of the United States, it would before this time have been found and recognised by the botanical collectors who have traversed and examined those countries.

From the Baron de Humboldt's observations on the potato in Mexico†, it seems certain that it is not wild in the southwestern part of North America; nor is it known otherwise than as a garden plant in any of the West India islands. Its existence, therefore, remains to be fixed in South America, and it seems now satisfactorily proved, that it is to be found both in elevated places in the tropical regions, and in the more tem-

* From the Horticultural Transactions.

† *Political Essay on the Kingdom of New Spain*. Black's Edition. Vol. II. page 484.

perate districts on the western coasts of the southern part of that division of the new world.

According to Molina*, it grows wild abundantly in the fields of Chili, and in its natural state is called by the natives *Maglia*, producing, when uncultivated, small and bitter tubers. The Baron de Humboldt asserts†, that it is not indigenous in Peru, nor on any part of the Cordilleras situated under the Tropics. But this statement is contradicted by Mr. Lambert‡, on the authority of Don Jose Pavon and of Don Francisco Zea; the former of whom says, that he and his companions, Dombey and Ruiz, had not only gathered the *Solanum tuberosum* wild in Chili, but also in Peru, in the environs of Lima; and the latter has assured Mr. Lambert, that he had found it growing in the forests near Santa Fé de Bogota. The above account of Pavon is further confirmed by the evidence of a specimen gathered by him in Peru, and now forming a part of the herbarium of Mr. Lambert, with the name of "Patatas del Peru."

Mr. Lambert, in his communication to the *Journal of Science and the Arts*, which I have referred to, supposes that the wild potato is to be found on the eastern, as well as the western and northern sides of South America. His opinion on this point appears to have been founded on the following circumstances:

Among the specimens in the Herbarium formed by Commerson, when he accompanied Bougainville in his voyage round the world, is one of a *Solanum*, gathered near Monte Video. In the *Supplement to the Encyclopédie*, (Vol. III. p. 746), this specimen was described, on the authority of M. Dunal of Montpellier, as belonging to a species distinct from *Solanum tuberosum*, under the name of *Solanum Commersonii*, and it was subsequently published by M. Dunal, with the same name in the *Supplement* to his *Solanorum Synopsis*§. (The article from the *Encyclopédie* is given below ||). Mr. Lambert, however, conjectured this spe-

* *Hist. Nat. du Chili*, p. 102.

† *Political Essay on the Kingdom of New Spain*. Black's Ed. Vol. II. p. 489.

‡ *Journal of Science and the Arts*. Vol. X. page 25.

§ Page 5.

|| Morelle de Commerson. *Solanum Commersonii*. *Solanum caule herbaceo, piloso; foliis pinnatis sublyratis, pilosis: floribus corymbosis, terminalibus; pedicellis articulatis*. Dun. Suppl. Sol. MSS.

cimen to be that of the type of the cultivated potato, and was induced to do so by information received from Mr. Baldwin, an American botanist, that he had found the *Solanum tuberosum* wild, both at Monte Video, and in the vicinity of Maldonado, as well as from Captain Bowles, who had resided a considerable time at Buenos Ayres, and who had told him that this plant was a common weed in the gardens and neighbourhood of Monte Video.

The above statements certainly confirm the existence of a plant in sufficient abundance near the shores of the Rio de la Plata, which Mr. Lambert identifies with Commerson's specimen; but the proof that it is the *Solanum tuberosum*, in opposition to the decision of Mr. Dunal, rests only on the opinion of Dr. Baldwin, and Captain Bowles, without the usual satisfactory evidence of specimens, which have not been supplied by either of these gentlemen.

In order to elucidate the question as much as possible, I applied to M. Desfontaines, Director of the Museum of Natural History in the Jardin du Roi at Paris, for permission to have a drawing made of Commerson's original specimen, which was deposited in the Herbarium under his charge. With a liberality and kindness which I cannot too highly compliment, the entire specimen was, without delay, transmitted to me. It has much the appearance of being in a dwarf or stunted state. The label affixed to it is thus described: "Hispanis Tomates—flores sunt palliduli—de la plage du pied du Morne de Monte Video en Mai, 1767." The size of the blossom is evidently larger than that of the *S. tuberosum*, under similar circumstances; the depth of the divisions of the flowers, and the larger proportional size of the terminal leaf, present striking differences from correspondent parts of the common potato.

Toute la plante est couverte de poils simples; elle a les plus grands rapports avec le *Solanum tuberosum*; elle en diffère, 1°. par ses feuilles profondément pinnatifides comme celle de la Pomme de terre, mais dont les folioles sessiles ne sont pas alternativement inégales. 2°. par la foliole impaire, qui est très grande. 3°. par la corolle, qui est à cinq divisions non à cinq angles. La racine de cette plante est encore inconnue.

Very little hairiness is perceptible on the specimen, which, if it had been taken from a plant of *S. tuberosum*, would probably have been much more hairy, as it usually is when stunted. It is also somewhat singular that Commerson, who could not but know the *S. tuberosum* and its various names, should have affixed that of "Tomates" to his specimen; this makes it almost certain that he did not consider it to be the potato. On these grounds I have ventured to hesitate in concurring in the opinion of Mr. Lambert, that we have sufficient evidence of the growth of the wild potato in the neighbourhood of the Rio de la Plata. It possibly may be found there, but its existence in that part of America is not proved, since it seems tolerably certain that Commerson's plant is not it, and Mr. Lambert does not suppose that the plants seen by his correspondent and friend were different from Commerson's.

Early in the spring of the present year, Mr. Caldcleugh, who had been some time resident at Rio Janeiro, in the situation of Secretary to the British Minister at that Court, where he had been indefatigable in his exertions to forward the objects of the Horticultural Society, returned to England, having previously taken a journey across the country, and visited the principal places on the western coasts of South America. Among many articles of curiosity which he brought with him, were two tubers of the wild potato, which he sent to me with the following letter:

Montague Place, Portman Square, February 24th, 1823.

MY DEAR SIR,

It is with no small degree of pleasure that I am enabled to send you some specimens of the *Solanum tuberosum*, or Native Wild Potato of South America.

It is found growing in considerable quantities in ravines in the immediate neighbourhood of Valparaiso, on the western side of South America, in lat. $34\frac{1}{2}$ S. The leaves and flowers of the plant are similar in every respect to those cultivated in England, and elsewhere. It begins to flower in the month of October, the spring of that climate, and is not very prolific.

The roots are small and of a bitterish taste, some with red and others with yellowish skins. I am inclined to think that this plant grows on a large extent of the coast, for in the south of Chili it is found, and called by the natives *Maglia*, but I cannot discover that it is employed to any purpose.

I am indebted for these specimens to an officer of His Majesty's ship *Owen Glendower*, who left the country some time after me.

I am, my dear Sir, ever sincerely your's,

ALEXANDER CALDCLEUGH.

The two tubers were exhibited to the Society, and a drawing made of them before they were planted. Had there been a third, I should have been tempted to have satisfied myself as to the real flavour, which Mr. Caldcleugh, as well as Molina, describes as bitter. They were planted separately in small pots, and speedily vegetated; they grew rapidly, and were subsequently turned out into a border at about two feet distance from each other, when they became very strong and luxuriant. The blossoms at first were but sparingly produced, but as the plants were earthed up they increased in vigour, and then bore flowers abundantly; but these were not succeeded by fruit. The flower was white, and differed in no respect from those varieties of the common potato which have white blossoms. The leaves were compared with specimens of several varieties of the cultivated potato, which generally were rather of a more rugose and uneven surface above, and with the veins stronger and more conspicuous below, but in other respects there was no difference between them. The pinnulæ which grew on the sides of the petiole, between the pinnæ of the leaves, were few, not near so numerous as in some varieties of the cultivated potato; but in specimens of other varieties that were examined, their leaves were destitute of pinnulæ, so that the existence of these appendages does not appear to be so essential a characteristic as has been supposed, and as is stated in the *Supplement to the Encyclopedie*.

The earth with which the plants had been moulded up had

been applied in considerable quantity, so as to form a ridge, the sides of which were full two feet high; and about the month of August, runners from the roots and joints of the covered stems protruded themselves towards the surface of the ridge in great numbers, and when they reached the light, formed considerable stems, bearing leaves and blossoms, so that at length the two plants became one mass of many apparently different plants issuing from all sides of the ridge. The appearance of these runners in such quantities induced a doubt as to the identity of the plant with our common potato, which doubt was increased when it was ascertained, that so late as the month of August no tubers had been formed by the roots. The runners were, however, no otherwise different from what are formed by the cultivated potato under ground, except that they were more vigorous, as well as more numerous.

The plants have recently been taken up, and all doubt respecting them is now removed; they are unquestionably the *Solanum tuberosum*. The principal stems, when extended, measured more than seven feet in length; the produce was most abundant, above six hundred tubers were gathered from the two plants; they are of various sizes, a few as large or larger than a pigeon's egg, others as small as the original ones, rather angular, but more globular than oblong; some are white, others marked with blotches of pale red or white. The flavour of them when boiled was exactly that of a young potato.

The compost used in moulding up the plants was very much saturated with manure, and to this circumstance I attribute the excessive luxuriance of the growth of the stems; had common garden mould been applied, they would not probably have grown so strong, and I suppose that whilst the plants were thus rapidly making stems and leaves, the formation of the tubers was delayed, for the production of these has been the work of the latter part of the season; they cannot be called fully ripe, nor have they attained the size which they probably might have done if they had been formed earlier.

They will, however, answer perfectly for the purpose of reproduction (or for seed, as it is technically called), and they are

in sufficient plenty to be subjected to treatment similar to a common crop of potato. The result of another year's experience is necessary to enable us fully to observe on the merits and value of this new introduction; but the following changes already appear to have attended its subjection to cultivation;—the produce is most abundant, the tubers have lost all the bitterness of flavour which is attributed to them in the natural state, and their size is increased remarkably; from all which circumstances I am disposed to infer, that the original cultivators of this vegetable did not exercise either much art or patience in the production of their garden potatoes.

The increased growth of the potato, not only in these kingdoms, but almost in every civilized part of the globe, has so added to its importance, that any information respecting it has become valuable; the subject of this communication may therefore not be without interest. With the exception of wheat and rice, it is now certainly the vegetable most employed as the food of man; and it is probable that the period is at no great distance, when its extensive use will even place it before those which have hitherto been considered the chief staples of life. The effect, of the unlimited extent to which its cultivation may be carried, on the human race, must be a subject of deep interest to the political economist. The extension of population, will be as unbounded as the production of food, which is capable of being produced in very small space, and with great facility; and the increased number of inhabitants of the earth will necessarily induce changes, not only in the political systems, but in all the artificial relations of civilized life. How far such changes may conduce to, or increase the happiness of mankind, is very problematical; more especially when it is considered, that since the potato, when in cultivation, is very liable to injury from casualties of season, and that it is not at present known how to keep it in store for use beyond a few months, a general failure of the year's crop, whenever it shall have become the chief or sole support of a country, must inevitably lead to all the misery of famine, more dreadful in proportion to the numbers exposed to its ravages.

Under such circumstances, and with such a prospect, it is surely a paramount duty of those who have the means and power of attending to the subject, to exert themselves in selecting and obtaining varieties of potatoes, not only with superior qualities in flavour and productiveness, but which shall be less subject to injury by changes of weather when in growth, and which may possess the quality of keeping for a length of time, either in their natural state, or under the operation of artificial treatment. This is one of the objects to which the care and energies of the Horticultural Society ought to be directed. Under its auspices, and by its means, some new kinds have been brought into notice, but a wide field of exertion is still before it. With the potatoes cultivated in South America at the present time we are very little acquainted; there is one especially which has been heard of, but which has not yet reached us, known at Lima as the yellow or golden potato, and which is reported to be far superior in flavour to any now grown in Europe.

On the subject of the potato there is also a point of curiosity and much interest open to those who have leisure and opportunity of conducting the investigation. Several accounts of its introduction into Europe, and especially into Great Britain and Ireland, are before the public, differing from each other, and none exactly correct; the entire truth is probably to be extracted from the whole, and ought to be supported by references to the original authorities for the different facts. To these, in order to render the early history of the potato complete, an account of its original discovery, and the observations made on it by the first and early visitors to the shores of South America, should be obtained; and this research would probably lead to a detection of the circumstances attending its first introduction into Virginia, which is at present involved in obscurity.

ART. VI. *Observations on the Project of taking down and rebuilding London Bridge.*

[By a Correspondent.]

IT is a matter certainly of great interest to men of science, to know what effect the removal of a dam producing a fall of water westward at high water sometimes of two feet, and eastward at low water sometimes of nine feet, from a great river like the Thames, would have westward and eastward of that dam in respect to the bed and shores of such a river; and whether a more frequent inundation and saturation with water of the low lands will cause miasms and pestilential diseases again to prevail, should the means of stopping such inundations or of quickly draining off the water not be immediately obtained. They look forward with great anxiety to the experiment; and the knowledge that this dam has existed many centuries, that the river passes through a dense population, that the estates of individuals have been regulated by it, that the levels of the lowest floors of houses and those of the streets in the low lands adjacent, have reference to this habit of the river, adds much to the excitement; for the intenseness of the interest always increases with the hazard of the throw. The complaints of the inhabitants on the banks of the river, like those of the dumb creature subject to the knife of the surgeon, are not heard in the eager pursuit of knowledge, and in the speculation of future amelioration. There are others who have great influence, and are urgent for the demolition of London Bridge, looking to their own gain in the erection of a new one. A mathematician, like to him of Laputa, has brought his implements to the question, and, without sections, without levels, and ignorant of the soil over which the river flows, or against which it impinges at its sinuosities, knowing neither what may be overflowed, nor what may be sapped, has, by a kind of intuitive philosophical tact, determined that, after the removal of the dam, the stream will flow on as harmless and obedient as heretofore*. Presuming there may be some of your readers

* See Dr. Hutton's Answers, App. 4th Report, 1821.

unable to discover truth except by induction, and others costive of their belief in the delirations even of a great teacher, and thinking that they may be desirous of viewing this important question by any glass, however weak its power, your correspondent ventures to offer that by which he views the question, and solicits the shelter of a few pages for the following observations in your journal.

The writers on the ordinances of rivers consider the courses and velocities of them dependent on the nature of the ground over which they pass, as well as upon the heights from which their waters descend. For example, water descending from a height on rocky ground, which it cannot remove, rises, spreads, and forms a lake; and proceeds with diminished velocity to the lowest point, and there cascades; advancing at the rate of forty-five inches per second, it will drive flint stones about the size of an egg before it, and rise and spread until its velocity is reduced to thirty-six inches per second, when the stones remain at rest; proceeding among pebbles about an inch diameter, it serves them the same, rising and spreading until its velocity is reduced to twenty-four inches per second, when they remain at rest; proceeding through coarse gravel about the size of a marble, it serves it the same, rising and spreading until its velocity is reduced to twelve inches per second; and so it proceeds with diminished velocity according to the size of the grain, the velocity and the course always varying with the obstacles met with. Gravel, the grain being about the size of aniseed, will be at rest at a velocity of four inches per second; sand will remain at rest at a velocity of seven inches per second, and precipitate at six inches per second. Clay will remain at rest at a velocity of three inches per second*. By reference to the map of the river Thames west of London Bridge, and bearing the above-mentioned facts in mind, it will appear that the banks of the river from Nine Elms, a little above Vauxhall Bridge, to London Bridge may be considered artificially fenced, and only requiring additional aid by raising and wharfing to prevent over-

✓ * See *Principes d'Hydraulique*, par M. le Chev. Du Buat; *Expériences sur les Cours des Fleuves*, par M. Genneté; and the article *River*, *Ency. Brit.*

flowing and sapping, through any increased height and velocity of the current; and, consequently, as the waters will not be allowed to spread in a neighbourhood where land is so valuable, the bed of the Thames in this part must be deepened naturally if the current acquires increased velocity; and, therefore, the bridges in this part, especially Vauxhall and Westminster Bridges, which do not stand upon piles, must be secured. If proceeding from Fulham and impinging on the shore of Wandsworth and Battersea*, the water should find the soil less resistive than on the opposite bank of the Grove, Chelsea, and Ranelagh, and the banks be not artificially strengthened, the water may take a short cut at some high flood in its course to the sea from Fulham to Nine Elms, and place Battersea in Middlesex. The same principles will apply both to the effects of the flood and ebb tides, from an increased velocity, at the several bendings of the stream, and, without expensive wharfings and continual care after the dam is removed, the proprietors of lands on the river shores, where there are elbows, may expect sometimes to lose a rood, and sometimes an acre of their lands, together with their sheep and cows.

The present turbidness of the river, and the frequent shifting of some of the banks and shoals, shew it to be now sometimes at variance with its bed and banks. Hence it is necessary to ascertain the nature of the soil of the bed of the river and of its banks at the several points of situation up as high as Tide-end-town, wherever it may be hereafter, whenever there are buildings to be sapped†; and this inquiry should be made in the survey, which, by an extract from the report of Mr. Telford in the *Phil. Mag.* of May last, he has requested authority to get made, complaining that no such document exists; the persons examined before him since 1800 up to this session of parliament, as to the effect likely to be produced by the enlargement

* The river here is comparatively rough and rapid. The boatmen have a story, that a band of fiddlers at this place were in former times drowned, and that the river has been dancing here ever since. Another band are determined to make the land join in the jig.

† See Appendix, (A. 23, 3d Report. Lond. Port.) in which are given the borings from London to Blackfriars' Bridge, from which it appears that the bed of the river, in that part, is gravel and sand, coarse and fine.

of the water-way of London Bridge having been able to decide upon these matters without the data Mr. Telford now thinks necessary. Such a river as the Thames, which, at a mean width between London and Blackfriars Bridges, even now the dam exists, having a velocity in the mid stream of sixty-three* inches per second, or $3\frac{6}{10}$ miles per hour, at half flood, requires some respect to be paid to its speed, its windings, and its fences, and will be found indignant to an alteration of its ancient habits. The paradoxes which experiments on the flowing of waters present, the recent history of the Eau Brink as to its anticipated and its actual effect on the harbour of Lynn, the erroneous calculations of the Royal Academy of Paris in respect to the apparently simple question of the Paris aqueduct, and those of Desaguliers and M'Laurin as to that of Edinburgh, might cause some doubt of any opinion with sufficient data, and much more of the determinations of mere theory, from one of very advanced age, without any. The question relating to the effects of the removal of the dam westward, put in the following manner, would cause more inquiry than the present seems to have done.

What effect would the introduction of another river on the west side of London Bridge, of the same dimensions as the river Thames at London Bridge, with a fall into it of two feet, have upon the bed and banks westward at high water? What effect would the subtraction of a quantity of water, at low water, equal to the surface of the river, six feet in depth at that subtraction, have upon the river westward at that time of the tide? It has been maintained, with reference to a compensation clause in the bill for the new bridge, that, in cases of land-floods, the removal of the dam of London Bridge would not cause an increased height of the waters in the up country, but have a contrary effect. This position is true at all times of the ebbing, but not of the flowing; a high sea-flood meeting a high land-flood must dam back the latter, and at times two feet higher than at present, when the dam of the bridge is removed. For example, on the 28th of December,

* See 3d Report, Appendix. G. London Port, and Plate 20, Appendix. At Westminster, Mr. Labeye ascertained the velocity to be thirty-six inches per second.

1821, from the freshes, the whole of the up-country was so flooded that the inhabitants of the low-lands adjacent used boats in the streets; a sea-flood meeting such a flood, and suffered to rise two feet higher than it can at present, would have caused a greater extent of country to be flooded than suffered at that time *.

Those who favour the removal of the dam of London Bridge, should, during the present hot weather, take a boat at low water from London Bridge, and proceed up the river; and, whilst they enjoy the odour from the banks, contemplate the effects of lowering the water from four to six feet, consequent on such removal, occasionally requiring the boatman to sound the depth with his oar; it will then be manifest to them what a stinking ditch the river will become at low water. Though an expenditure of a large sum of money might dredge out a temporal channel for the navigation at that time, it must nevertheless be remembered, that the width of the river increases upwards from London Bridge, and there are no moveable dams, for which purposes the ships below London Bridge are used to keep it clear. The cause assigned for taking down London Bridge is as follows; "Whereas the great fall of water at certain times of the tide, occasioned by the large starlings and piers of the said bridge, renders the navigation through the said bridge dangerous and destructive to the lives and proper-

* The late Mr. Mylne's Report, Appendix (A 1) and Plate 1, 3d Report. London Port, without data, but from a practical fact, confirms the opinions contained in this paper. He was employed with a view to the demolition of London Bridge, and was a strenuous advocate for a new one. He contemplates the inadequacy of the sea-walls, but leaves, like the new bill, the care of them to the respective owners. If we may rely on the effect of the increased velocity on the bed of the Thames, which he anticipates, there will, soon after the dam is removed, be the materials of two or three bridges ready wrought at London Bridge for the new structure, without the trouble of stopping the receipts of the excise and customs of the three kingdoms. The fall of water, westward of London Bridge, has dug out the bed of the river, to a distance of four hundred feet, of twenty-eight feet in depth at the lowest point; and that, eastward from the ebbing and freshes, has dug out the bed of the river to a distance of six hundred feet, of thirty-four feet in depth below the bed at the lowest point; when the dam of the bridge is removed, this power will be principally spent in deepening the river upwards. The maintaining Blackfriars Bridge, even with the present bed of the river, ought to be more an object of solicitude than the destruction of London Bridge; its piers are in a very dilapidated state,—and it is to be remembered that the piles under them were not driven nor cut off within coffer-dams.

ties of His Majesty's subjects." By reference to the reports of the Committees of the House of Commons, of the sessions 1820 and 1821, relating to this bridge, ordered to be printed May and June, 1821, and upon abstracting from the evidence therein, relating to the loss of life and property in the last twenty years, the promoters of the demolition of the bridge cannot produce a statement of a greater number of persons drowned than 17, nor damage to property exceeding 4000*l.* by accidents at London Bridge, during that time. The evidence, with respect to the danger of the navigation through the bridge, of the lightermen examined, many of whom have navigated the river for forty years, is directly at variance with the opinions of those who are desirous of a new bridge, and attributes the accidents which occur to mere ignorance and drunkenness.

The sufficient stability of this bridge was ascertained in 1759, when the large arch was made, and unquestionably confirmed by the late examination of the structure of the piers *.

The sufficient width of the bridge as a roadway, is maintained by Mr. Rennie's evidence, (16th April, 1821,) who, upon being asked, "What would you propose to make the width of the new bridge?" answered, "The same width as the old one;" and added, London Bridge is wider than either Southwark, Blackfriars, or Waterloo Bridges. The width of the bridge, in the clear of the parapets, in the design which received the first premium, is only 44½ feet, a less width than between the parapets of the present bridge †; so that the mechanics and tradesmen who urge the necessity of a new bridge, in the hopes of having a freer thoroughfare for themselves and their carts, will be grievously disappointed.

In the late application to architects and engineers, it seems remarkable, that it had not occurred to the bridge committee,

* Appendix, Report on London Bridge, 1821, p. 66, &c.

† See Mr. Dance's section, Append. B. I. 2d Report, London Port. By Append. B. III. 3d Report, London Port, London Bridge is 45 feet wide, Blackfriars 41 feet, Westminster 39 feet 9 inches.

The late Mr. Mynle (App. B. II.) thought 50 feet a proper width for the new London Bridge. The roadway of Waterloo Bridge is 28 feet, the footpaths each seven feet, together 42 feet; the same as Westminster Bridge is stated to be by Mr. Labelye. Vauxhall Bridge has a roadway of 28 feet, and two footpaths of 5 feet 6 inches each, together 39 feet.

that the supposed evil might have another remedy than a new bridge ; and out of the course of ordinary proceeding. It might have suggested itself to some engineer, contemplating the direction of the mid-stream of the Thames towards Pepper-alley stairs, and the bank of gravel that directs it in that course ; or to some antiquary, who recollected King Canute's mode of conveying his fleet from the east side to the west side of London Bridge ; or the direction of the cut which was made in 1173, when this bridge was rebuilt,—that an auxiliary cut, and bridge, round the foot of the present structure, north of Tooley-street, might be a cheaper mode of obtaining the proposed object than a new bridge ; especially upon finding, upon inquiry, that between the linear waterway (690 feet) required, and the absolute linear waterway of the present bridge, (545 feet,) there is only a deficiency of 145 feet ; and between the superficial waterway of London Bridge, and that of the section of the whole river, from Old Swan-stairs to Pocock's Flour wharf, at high water, there is only a deficiency of about 4000 feet.

Others, deprecating the removal of the dam, but desirous of rendering the navigation, even when intrusted to unskilful and drunken lightermen, safe, and accustomed to view the locks on other rivers, and even upon this, may surmise, that the object might be obtained by locks *.

The cost of the repairs of this bridge annually, for the twenty years previous to 1818, varied between 6027*l.* and 1455*l.* The income of the estates applicable to the repairs of the bridge, for 1818, is stated to be 26,526*l.*, of which about 11,000*l.* were expended in management. The trustees, also, possessed stock

* Had the instructions to these candidates been unfettered, there might have been a renewal of Messrs. Douglas and Telford's scheme for a cast-iron bridge of 600 feet span, with a rise of 65 feet above high water, for vessels to sail above London Bridge, and only at the cost of 262,289*l.* The practicability and advisableness of this bridge was certified by twelve out of fifteen mathematicians and engineers, though, at that time, neither the designers, nor the committee, nor any of the mathematicians or engineers, knew the strength of cast iron ; and those who supposed they knew something of the matter, thought it forty times stronger than it since has been found to be : so easy is it to ask and receive opinions. But where a favourite object is to be carried, the data, upon which such opinions must be founded, are kept out of sight or misstated or an inquiry into them is refused.

and cash to the amount of 112,000*l.* It was intended that the corporation of London should take up the money, for the purposes of the new bridge, on the security of the Bridge House estates; but as they only produce an annual income of about 26,000*l.*, of which 11,000*l.* are required for management, there only remained 15,000*l.* per annum to pay the interest of money to be borrowed; and allowing the appropriation of a part gradually to pay off the principal, it became manifest, that the estates would not be security for more than 250,000*l.*, which, added to the 112,000*l.* in hand, afforded from these estates only 360,000*l.* towards the new bridge; this sum has wonderfully increased since 1818, so that the corporation are now able to give 200,000*l.*, and raise 400,000*l.*, and reserve for management, &c., 12,000*l.* per annum. Government is to give, also, 150,000*l.*, divided into annual payments, in seven years; during which time the public are to submit to the nuisance, both in respect to the navigation, and the thoroughfare over the river. Hence it appears, that there are about 750,000*l.* in embryo for the new bridge, squaring, of course, with the estimates; but, upon referring to the bill brought into parliament this session, for rebuilding London Bridge, there seems to have been originally some doubt as to the sufficiency of means*; for it will be found, that the commissioners of His Majesty's Treasury were to be allowed to issue exchequer bills for the approaches, and they were also to be allowed to pay the expenses of the act, and direct taxes were to be levied on the public, *on coals and wine* imported into the city of London, for liquidating and paying the interests of these Exchequer bills, under the screen of what is called the Orphans' Fund, and *indirectly, by the introduction of a clause to exempt the corporation "from the payment of any damage to persons, or their houses, estates, vessels, or property,* by reason of the increased rise of the tide of the said river above

* The amended bill makes the doubt approach to a certainty; for it is said to contain a specific clause, that no one shall be entitled to compensation for any nuisance, obstruction, or injury, on account of the bridge remaining unfinished, in case the sum or sums of money, to be raised and advanced, prove insufficient to complete the same.

the said bridge, or the alteration of the channels or currents of the said river, or of the want of water for navigating the same, nor for any *nuisance, obstruction, or injury*, to be occasioned thereby *."

But it being understood that the direct taxes might be indigestible, that part of the bill is struck out, and a less visible mode of taxation is to be adopted, by allowing the Commissioners of Customs and of Excise, of England, Ireland, and Scotland, with consent of the Lords of the Treasury, to remit taxes on stone, brick, timber, or other materials used in building the bridge, and its *appurtenances*. For this purpose, the ordinary course of government is to stop, and there is to be a particular interposition; but the poor people, who may be ruined in their fortunes, diseased by the damps and miasms caused by the saturation of their habitations by frequent floods, or overwhelmed by floods, from an inability to provide against them, consequent on this revolution of the ancient, and now constitutional, habit of the river, are left to the care of a higher Power, who has set his bow in the heavens as a token. The scheme seems now to be, to pass the act and get up the bridge, relying, in the case of a deficiency of money to rebuild it, that government would be compelled, by the urgency of the occasion, to provide the means. Such a scheme, in respect to the Post-office, failed: but that was a singular case, an exception to the general success of such policy.

The new bridge, proposed by the late Mr. Rennie, was	
estimated by him to cost	£430,000
A temporary bridge	20,000
The purchase of property } On the north side	150,000
for approaches, } On the south side	150,000
£750,000	

This sum, by reference to absolute costs, compared with estimates of other works of the same kind, might with propriety be taken as half the cost, even could we not see the causes from which such an excess would arise, viz., at £1,500,000

* Those who have built their houses low in the low-lands, and feed their cattle there, the proprietors, and others, who have allowed the foundations of their bridges to be laid at an insufficient depth, are informed that they came to the river, and not the river to them; and that they ought, in choosing such a neighbour, to have provided against such an event as the proposed alteration of the habits of it.

But we have the following items * of charge, by which we may guess that doubling the estimate will be found too small an allowance for contingencies.

1. The bridge is to be erected in a hole where the depth of water, at high water, is 46 feet.
2. The approaches are to be made through property of great value, and in a thoroughfare of persons and carriages as close as sheep in a flock.
3. On removing the old bridge.
4. On raising about 40 miles of river wall, varying from 24 to 26 inches in height, and strengthening the banks by wharfing and piling, in order to provide against the effects of frequent floods, expectant on giving a freer water-way, and increased velocity and height, to the current.
5. On dredging out a channel for the current at low water, for the navigation.
6. On the necessity of narrowing the river in several parts.

* Many great losses will be sustained by individuals under the heads of these items, but for which, they will be shut out from having any compensation from the city; nevertheless, they must be considered part of the cost of the new bridge. It may be proper to inquire, who are to be subject to these actions, suits, indictments, claims, and demands, which are thus shifted from the mayor, commonalty, and citizens? On the northern shore, we find, among others, the Duke of Northumberland, the Rev. William Lowth, the Duke of Devonshire, the owners of Fulham Town Meadow, Viscount Cremorne, Lord Cadogan, Lord Grosvenor, the Chelsea Waterworks Company, the Crown, and others.

From Teddington eastward to Cotton stairs, near Westminster Bridge, all the river walls are defective in height to resist such a flood as that of the 28th December, 1821, that deficiency varying from one foot at Twickenham, to two feet five inches at Cotton Garden stairs; but, generally, in the less populous parts westward, the walls are from three to five feet below that level; while the lands in the populous parts northward are greatly below it; for example, Walham-green and Chelsea are from one to five feet below this level. The ground of the Penitentiary is eight feet below this level. The Vauxhall Bridge road, and Tothill-fields, are generally from three to four feet below this level. St. James's Park, on the south side, varies from sixteen inches to eight feet below this level; and there are various defective banks or ways, as far eastward as the Duchess of Buccleugh's, for the water to get to these parts: It will be the duty of the commissioners of sewers forthwith to give notice to the various proprietors to repair their banks, by raising or otherwise; and it will be a matter determinable by the custom or peculiar laws of the commissioners, whether, in default of complying with such notices, the commissioners may direct the proper raisings and wharfings to be done, and rate the proprietors of the banks for the cost, or leave them to the actions, suits, indictments, &c., of which the mayor and commonalty are so apprehensive.

After the demolition of the dam of London Bridge, this level will be that of not a very uncommon high sea-tide, west of London Bridge.

7. On removing shoals and sand-banks, caused by the alteration in the directions of the mid stream.
8. On the erection of starlings round the piers of the different bridges, and especially round Vauxhall and Westminster bridges, which do not stand upon piles. The bridges above London bridge generally stand in shallow water, and the foundations of them are very little below the bed of the river, which may be undermined; for a greater depth must be effected artificially, in the first instance, for the navigation, and subsequently, by the increased velocity of the stream, in a manner which cannot now be guessed at *.
9. On the necessity of erecting another dam, or locks, to keep up the water, as a substitute for the dam taken down, the necessity for which, the locks up the river, beginning at Teddington, prove †.
10. On the damage to shipping below the bridge, in times of frost, by ice now stopped, at such times, by London bridge.
11. On compensations to persons possessed of wharfs, adapted to the present state of the river above and below the bridge, for damage to them by the alterations in the course of the stream, and the shifting of the sand banks.
12. On compensation to persons whose trades are dependant on the free thoroughfare over the bridge, living south and north thereof, for seven years, during the erection, or while it remains unfinished for want of funds to complete it.
13. On compensation to persons navigating the river, for property destroyed, and loss of life, during the erection of the bridge, and while it may remain unfinished for want of

* The head of water maintained by the lock at Teddington in winter is one foot, in summer four feet; a similar head is maintained at Moulsey. Dams are erected here to keep the water up the country; but the dam of London Bridge is to be taken down to let it out.

† The bottom of the foundations of the piers of Westminster Bridge are five feet below the bed of the river, allowing two feet three inches, as at Blackfriars Bridge, for grating; the bottom of the stone is only two feet nine inches below the bed. The bottom of the foundations of the piers of Blackfriars Bridge is three feet nine inches below the bed, the bottom of the stone 18 inches. How much below the bed of the river are the foundations of Vauxhall, Waterloo, and Southwark Bridges? The bottom of the stone piers of Waterloo Bridge are only 15 feet below the springing of the arches.

money to complete it, which, at a moderate estimate, may be taken to exceed the same loss arising from the old bridge in the last twenty years.

Hence, in any view of the question, it would be unreasonable to consider the cost of this bridge at less than *one million and a half*.

These observations may probably, through your Journal, cause more inquiry to be made into this important question, than the impatient determination, at any rate to have a new bridge, has hitherto allowed. They may make the failure of the proof of the expediency of removing the dam of the bridge manifest; also shew the deficiency of the means for building the bridge, without taxes to a large amount being eventually levied on the public; and remove the general delusion, that the thoroughfare over the bridge will be more free than it is at present. They may cause some reflections on the forbearance of the government regarding the public dignity, but scrupulous of increasing the public expenditure, in listening for a moment to such an useless and dangerous expense, which, directly or indirectly, will cause taxes to be raised to pay a million at least, WHILE THE WANT OF A PALACE IS A GENERAL REPROACH TO THE NATION, AND A SUBJECT FOR DERISION WITH EVERY FOREIGNER.

ART. VII. *Estimate of the Force of Explosion of Coal Gas; laid before the Committee of the Royal Society in the Year 1814.*

[By one of its Members.]

It must be confessed, that without direct experiments on the force of any exploding compound, we can obtain nothing more than probability by calculating from the analogy of other similar effects: but provided that we take sufficient care not to underrate the forces in question, we may obtain, from such a comparison, at least a useful estimate of their greatest possible magnitude.

Dr. Henry has found (*Phil. Trans.* 1808), that good coal gas requires for its combustion, about twice its bulk of oxygen gas, and affords a little more than its bulk of carbonic acid. Now since common air contains only 21 per cent. of oxygen, it can combine with no more than 12 per cent. of coal gas; so that 112 parts of the mixture contain but 33 of substances capable of affording heat, while the remainder tends, in some measure, to impede their union. Hence we cannot suppose the heat, thus generated, to exceed about $\frac{1}{4}$ of the heat which would be excited in a mixture of the gas with pure oxygen. And we shall probably exceed the truth, in allowing to the combustion of such a mixture, a heat equal to that which is evolved in the deflagration of gunpowder; which is sufficient, upon the most probable estimate, to increase in the ratio of 1 to 80, the natural elasticity of the fluids generated, which amount to 250 times the bulk of the powder, so that the elasticity, thus augmented, becomes equal to 20,000 atmospheres. It is true, that some of the solid substances contained in gunpowder may possibly be converted into vapour, and may contribute to its effect: but we have no sufficient reason to believe that the vapours of any of these substances would be more elastic than air; and Count Rumford's hypothesis, concerning the effect of steam, is every way inadmissible; since even if nitre contained water of crystallization, its vapour would be little more effectual than an equal weight of the gaseous substances.

We may, therefore, suppose the exploding mixture to acquire a degree of heat, capable of increasing its elasticity in the ratio of 1 to 20. Dr. Ingenhousz, following Robins, makes the explosive force of a mixture of oxygen and hydrogen equal to 4 atmospheres only: but the assumption of a degree of heat equal only to that, which Robins obtained in a fire, is wholly arbitrary: and a single drop of ether, in a bottle of oxygen, appears to have exploded with a force much more than commensurate to such a cause. On the other hand, when we consider with what safety a mixture of oxygen and hydrogen may be made to explode in a common quart bottle of green glass, we cannot hesitate to allow that 80 atmospheres must be a very ample estimate

of the force of explosion of a mixture of oxygen and coal gas. As the ignited gas expands, it loses a portion of its elasticity, not only by the diminution of its density, but also by the effect of the expansion on its temperature, which may be estimated as altering the elasticity in the proportion of the biquadrate root of that of the densities.

Calculating upon these grounds, we find that the whole mechanical power of an explosion of 15,000 cubic feet of a mixture of coal gas, and common air, is equal to that of the explosion of 6 cubic feet, or 4 barrels, of gunpowder; and if we suppose the heated gases in both cases to escape, and mix with the common air in a building containing 30,000 cubic feet, so as to produce an effect commensurate to the temperature of the whole mixture, the explosion of about 15 cubic feet, or 10 barrels of gunpowder, would be required, in order to produce, like the gas, a force of about 10 atmospheres for the whole space. It must, however, be recollected, that gunpowder, thus disposed, is very unfavourably situated for producing violent effects; and that a much smaller quantity, in ordinary cases, would be more formidable than the explosion of the coal gas.

A more precise idea of the effects of such an explosion may be obtained from the calculation of its projectile effects, which would carry some parts of the wall of the surrounding building to a height of nearly 150 yards, and others to a distance of nearly 300. If the walls were in immediate contact with the gasometer, the height and distance would be about twice as great. But a roof of carpentry and tiles being lighter, would be carried higher, while the lateral force of the explosion would be diminished.

Supposing the explosion of the gas to be unconfined, the shock would throw down a brick wall, 9 feet high, and 18 inches thick, at the distance of about 50 feet from the centre; it would probably break glass windows at 150 yards, and at 300, would produce an effect similar to the instantaneous impulse of a very high wind.

CALCULATION.

In order to compare the whole forces of expansion in a con-

finer channel, let the length occupied initially by the gas be a : then, when it becomes ax , the elasticity will be diminished in the ratio of 1 to $x^{-\frac{5}{4}}$; and the force will be expressed by $nx^{-\frac{5}{4}} - 1$, and the fluxion of half the square of the velocity by $nax^{-\frac{5}{4}}\dot{x} - a\dot{x}$; and the fluent will be $-4nar^{-\frac{1}{4}} - ax$, which is initially $= -4na - a$, and finally, when $nx^{-\frac{5}{4}} - 1 = 0$, and $x = n^{\frac{4}{5}}$, and $n = x^{\frac{5}{4}}$, $= -4ax - ax$; and the difference showing half the square of the velocity generated, is $(4n + 1 - 5n^{\frac{4}{5}})a$. When $n = 20$, the expression becomes $26a$; when $n = 20\,000$, $66\,204a$; and in order to make these values equal, the latter value of a must be $\frac{1}{2540}$ of the former; and $\frac{15000}{2540} = 5.9$.

In a similar manner, when a is the radius of a sphere, or of a hemisphere, which expands in every direction, the elasticity will vary as $x^{-\frac{15}{4}}$, and the fluxion will be $nax^{-\frac{15}{4}}\dot{x} - a\dot{x}$, and the fluent $= \frac{4}{11}nax^{-\frac{11}{4}} - ax$; which, being corrected, gives for the half square $\left(\frac{4}{11}n+1 - \frac{15}{11}n^{\frac{4}{5}}\right)a$.

The fluent, thus found, may be compared with the feet in which the force of gravity would produce an equal velocity, by increasing it in the ratio of the pressure of an atmosphere to the weight to be moved: that is, for a brick wall 18 inches thick, multiplying it by 11: so that, when $n = 20$, and $a = 15$, $.5242a = 865$ feet, the height of ascent: or, supposing the space doubled, and $n = 10$, and a about $18\frac{1}{2}$, the height would be 430 feet.

Where the explosion of the gas takes place without an obstacle, the mean force being about $\frac{5.242}{2.223}$ atmospheres, the velocity of expansion will be about 2000 feet in a second; or, perhaps, a little greater, on account of the lightness of the gas;

but this excess will be compensated, when the velocity is afterwards communicated to the surrounding atmosphere. With this velocity, the centre of inertia of each elementary pyramid of the sphere will advance from the distance $\frac{3}{4} \times 15$ to $\frac{3}{4} \times 33.35$ feet, through $13\frac{3}{4}$ feet, in $\frac{1}{145}$ of a second: and at any greater distance d , the velocity of the impulse will be reduced from 2000 to $2000 \times \frac{25}{d}$, or $\frac{50000}{d}$, its duration being always $\frac{1}{145}$ of a

second. Thus the velocity of a very high wind being 60 feet in a second, the impulse would retain this force at the distance of 833 feet: and in order to determine at what distance it would overset a wall 9 feet high, and $1\frac{1}{2}$ thick, we must first find the height through which the centre of oscillation of the wall, at $\frac{2}{3}$ of its height, must ascend, in order to be immediately over the point of support, that is $\sqrt{(36 + 1)} - 6 = \frac{1}{12}$ of a foot: and

the velocity corresponding to this height would be generated by the force of gravity in $\sqrt{\frac{1}{193}} = \frac{1}{13.9}$ of a second: and

in order to be generated in $\frac{1}{145}$, it requires a force 10.43 times as great, or equal to the pressure of a column of brick 15.64 feet high; that is, $15.64 \times 125 = 1955$ pounds for every square foot; which is equivalent to the pressure occasioned by a velocity of 966 feet in a second, and answers to a distance of 52 feet.

ART. VIII. *On the Crystalline Forms of Artificial Salts.*
By Mr. LEVY. *Communicated by the Author.*

THE relation between the chemical composition of a substance, and its crystalline form, has not yet been ascertained; and it is only from a comparative examination of the exact analyses and forms of a great many simple and compound bodies, that it may be expected to be deduced. The data furnished by Mineralogy are not sufficient to discover it; because not only there are too few simple compounds found crystallized, but also because those which are met with have

not a sufficient chemical analogy. On the contrary, the composition of the substances crystallized artificially is better known than that of minerals, or at least more easily ascertained; and, perhaps, a sufficient number among them, having a certain desired relation of composition, may be examined, to lead to some important result. It is in this point of view that the determination of their forms appears to me to deserve attention.

This subject has acquired, lately, a new degree of interest, from the two papers of Mr. Mitscherlich. He has himself examined a great many artificial crystals, and has given, in the last of his two papers, it seems, with great accuracy, the forms and complete determination of many salts produced by the combination of the phosphoric and arsenic acid with several bases. His object is to establish, that the same number of atoms, combined in the same manner, produce the same crystalline form; and that the same crystalline form is independent of the chemical nature of the atoms, and is only determined by their number and relative position. In both his papers, and especially in the last, will be found the facts and reasons he adduces in support of this opinion; and, I think, that after their perusal, even those who are most adverse to generalization, must, at least, admit that the analogies and identities of forms, which he has noticed in several compounds, are extremely interesting. Another proposition he advances is, that the same substance may crystallize under two different and incompatible forms; and mentions, as examples, carbonate of lime and arragonite, and the two forms he has obtained for the bi-phosphate of soda*.

The preceding considerations, and the results obtained by Mr. Mitscherlich, made me very desirous to begin an examination of artificial crystals; and having mentioned my intention to Mr. Children, he very kindly offered to take his share of the

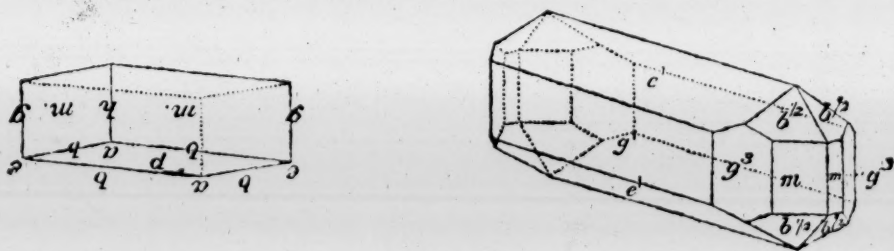
* There is not, however, the same degree of incompatibility between the two forms of the bi-phosphate of soda, as between those of arragonite and carbonite of lime, the one being a right rhombic prism, and the other a rectangular octahedron; but I suppose, Mr. M. has satisfied himself that the one could not simply be deduced from the other.

work, by preparing the crystals, upon the purity of which I could therefore depend. At his recommendation, Mr. Brande has also allowed me to select some crystals from those in his collection, preserved in the laboratory of the Royal Institution, and at Apothecaries' Hall.

With this help, I propose to employ some leisure hours to the determination of as many crystallized substances as I shall be able to procure. This paper, and some subsequent ones, will contain the result of my researches. Besides the primitive, I shall give one or two of the forms which most commonly occur. I measure the angles with a goniometer belonging to Mr. Lowry, and which is divided to half a minute; and I besides use the principle of the repetition of angles, in order to obtain a greater accuracy. At the suggestion of Dr. Wollaston, I call the solid, from which the secondary forms are supposed to be derived, by the appellation of *primitive*, when obtained by cleavage; and by that of *primary*, in the contrary case. I designate the angles and edges of the primitive, by the same letters as Häuy; and the secondary planes, by the signs of the decrements from which they are supposed to result.

I have begun with the salts of potash.

Nitrate of Potash.



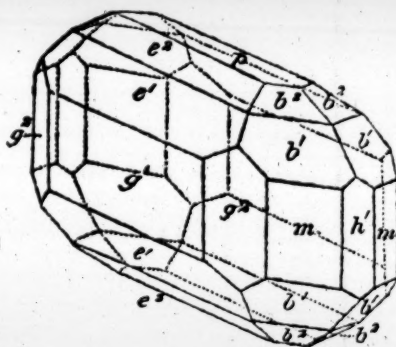
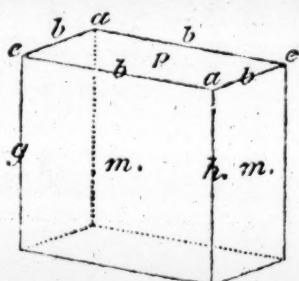
Incidences.

m on m	109° 50'
$b\frac{1}{2}$	135 36
g^2	160 42
e^1 on g^1	120 25

Primitive form.—A right rhombic prism, the incidence of the two lateral planes of which is 109° 50', and the ratio between one side of the base and the height nearly that of 1 to 0,48.

Cleavage.—Parallel to all the faces of the primitive, and also to a plane passing through the two short diagonals of the bases.

Sulphate of Potash.



Incidences.

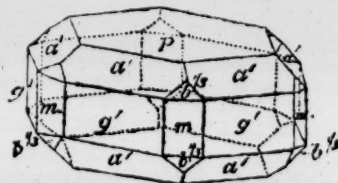
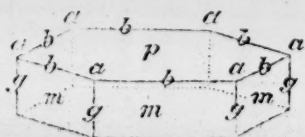
m on m	$120^{\circ} 30'$	m on P	$90^{\circ} 0'$
b^1 on m	$146 22$	b^1	$123 28$
b^2	$126 56$	b^2	$143 4$
g^1	$119 45$	e^1	$123 50$
g^2	150	e^2	$143 17$
h^1	$150 15$		

Primitive form.—Right rhombic prism, the incidence of the two lateral planes of which is $120^{\circ} 30'$, and the ratio between one edge of the base and the height, nearly that of 10 to 13.

Cleavage.—Parallel to all the faces of the primitive form, and also to planes passing through both the diagonals of the bases.

In many of the small crystals, the faces P , b^1 , b^2 , h^1 , do not occur.

Hyposulphate of Potash.



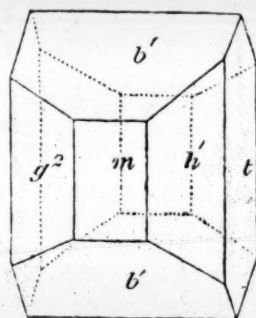
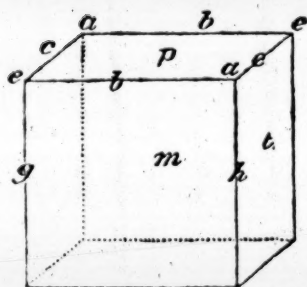
Incidences.

m on m	120°	m on P	$90^{\circ} 0'$
g^1	150	a^1	$143 22$
		$6\frac{1}{2}$	$127 50$

Primitive form.—A regular six-sided prism, in which one side of the base is to the lateral edge in the ratio of 1 to 0,37.

Cleavage.—Parallel to all the faces of the primitive form.

Bi-carbonate of Potash.



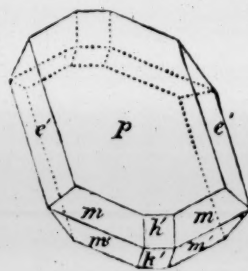
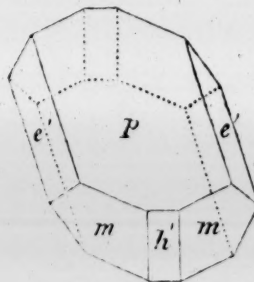
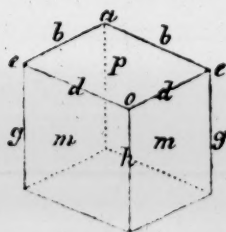
Incidences.

m on t	103° 41'
on h^1	126 51
h^1 on t	156 50
g^2 on m	127 33
b^1 on m	111 5

Primitive form.—A right oblique-angled prism of $103^\circ 41'$, in which the three edges b, c, h are nearly in the ratio of the number 1, 2,03 and 0,762.

Cleavage.—Parallel to the lateral planes of the primitive, and also to a plane passing through the two edges g .

Chlorate of Potash.



Incidences.

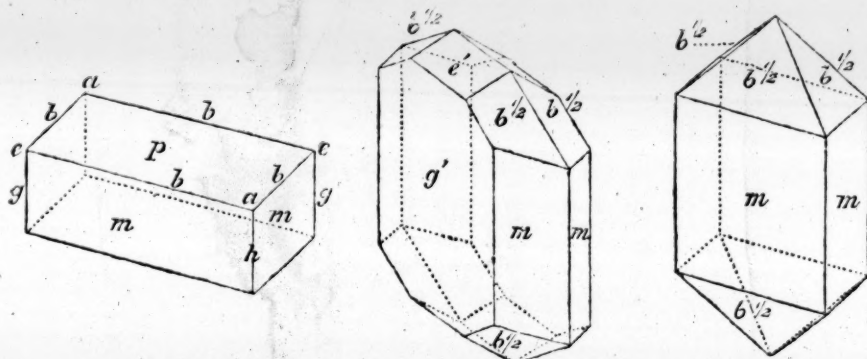
m on m	103° 55'
P	105 34
h^1	141 57 30''
e^1 on P	129 50

Primitive form.—An oblique rhombic prism, the lateral planes of which are inclined at an angle of $103^\circ 55'$; and the base, upon each of the lateral planes, of $105^\circ 34'$. The lateral edge is very nearly equal to one side of the base.

Cleavage.—Parallel to all the faces of the primitive form.

Most of the crystals I have observed were macles as represented in the third figure.

Sub-chromate of Potash.



Incidences.

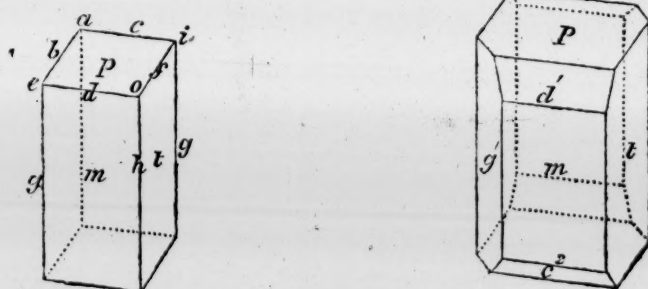
m on m	107° 8'
P	90
e_1 on g^1	120 50
$b_{\frac{1}{2}}$ on m	130 10

Primary form.—A right rhombic prism of 107° 8', in which the ratio of one side of the base, to the lateral edge of the prism, is nearly that of 5 to 2.

Cleavage.—None very distinct.

This is the yellow chromate of potash, which, from the remarks of Mr. Taffaert, in the *Annales de Chimie* for 1823, appears to be a sub-chromate.

Bi-chromate of Potash.



Incidences.

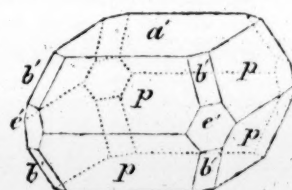
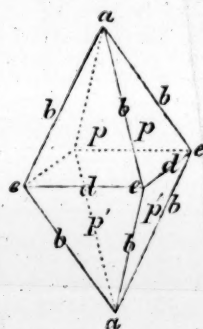
	on m	on P	on t
P	98° 14'	0°	91° 36'
m	0	98 14	96
t	96	91 36	0
d^1	142 6	136 8	85 44
g^1	114 33	94 19	149 27
c^2	113 2	31 16	

Primitive form. A doubly oblique prism, in which the incidences of the base p , on the two lateral planes m , t , are, re-

spectively, $98^{\circ} 14'$, and $91^{\circ} 36'$; and that of m on t , 96° ; the lengths of the three edges, f , d , h , meeting in the point o , are nearly in the ratio of the numbers 1., 0.55, 1.125.

Cleavage.—Very easily obtained, parallelly to all the planes of the primitive.

Prussiate of Potash.



Incidences.

P on P	$98^{\circ} 11'$
P^1	$135 \quad 40$
a^1	$112 \quad 10$
b^1 on a^1	$119 \quad 57$
e^1	90

Primary form.—Octahedron, with a square base, in which the incidence of two adjacent faces of the upper pyramid is $98^{\circ} 11'$.

Cleavage.—Easy, in a direction perpendicular to the axis of the octahedron.

[To be continued.]

ART. IX. *Historical Statement respecting Electro-Magnetic Rotation.* By M. FARADAY, Chem. Assist. in the Royal Institution.

IN the XIIth Volume of this Journal, at page 74, I published a paper on some new electro-magnetical motions, and on the theory of magnetism. In consequence of some discussion, which arose immediately on the publication of that paper, and also again within the last two months, I think it right, both in justice to Dr. Wollaston and myself, to make the following statement:—

Dr. Wollaston was, I believe, the person who first entertained the possibility of electro-magnetic rotation; and if I now understand aright, had that opinion very early after repeating Professor Oersted's experiments. It may have been about August 1820, that Dr. Wollaston first conceived the possibility of making a wire in the voltaic circuit revolve on its own axis. There are circumstances which lead me to believe that I did not hear of this idea till November following; and it was at the beginning of the following year that Dr. Wollaston, provided with an apparatus he had had made for the purpose, came to the Institution with Sir Humphry Davy, to make an experiment of this kind. I was not present at the experiment, nor did I see the apparatus, but I came in afterwards, and assisted in making some further experiments on the rolling of wires on edges*. I heard Dr. Wollaston's conversation at the time, and his expectation of making a wire revolve on its own axis; and I suggested (hastily and uselessly) as a delicate method of suspension, the hanging the needle from a magnet. I am not able to recollect, nor can I excite the memory of others to the recollection of the time when this took place. I believe it was in the beginning of 1821.

The paper which I first published was written, and the experiments all made, in the beginning of September, 1821. It was published on the 1st of October; a second paper was published in the same volume on the last day of the same year. I have been asked, why in those papers I made no reference to Dr. Wollaston's opinions and intentions, inasmuch as I always acknowledged the relation between them and my own experiments? To this I answer, that upon obtaining the results described in the first paper, and which I shewed very readily to all my friends, I went to Dr. Wollaston's house to communicate them also to him, and to ask permission to refer to his views and experiments. Dr. Wollaston was not in town, nor did he return whilst I remained in town; and, as I did not think I had any right to refer to views not published, and as far as I

* See Sir Humphry Davy's Letter to Dr. Wollaston. *Phil. Trans.* 1821. p. 17.

knew not pursued, my paper was printed and appeared without that reference whilst I remained in the country. I have regretted ever since I did not delay the publication, that I might have shewn it first to Dr. Wollaston.

Pursuing the subject, I obtained some other results which seemed to me worthy of being known. Previous to their arrangement in the form in which they appear at page 416 of the same volume, I waited on Dr. Wollaston, who was so kind as to honour me with his presence two or three times, and witness the results. My object was then to ask him permission to refer to his views and experiments in the paper which I should immediately publish, in correction of the error of judgment of not having done so before. The impression that has remained on my mind ever since, (one-and-twenty months,) and which I have constantly expressed to every one when talking of the subject, is, that he wished me not to do so. Dr. Wollaston has lately told me that he cannot recollect the words he used at the time; that, as regarded himself, his feelings were it should not be done, as regarded me, that it should; but that he did not tell me so. I can only say that my memory at this time holds most tenaciously the following words: "I would rather you should not;" but I must, of course, have been mistaken. However, that is the only cause why the above statement was not made in December 1821; and that cause being removed, I am glad to make it at this, the first opportunity.

It has been said I took my views from Dr. Wollaston. That I deny; and refer to the following statement, as offering some *proof* on that point. It has, also, been said, that I could never, unprepared, have gained, in the course of eight or ten days, the facts described in my first paper. The following information may elucidate that point also:

It cannot but be well known, (for Sir Humphry Davy himself has done me the honour to mention it,) that I assisted him in the important series of experiments he made on this subject. What is more important to me in the present case, however, is not known; namely, that I am the author of the *Historical Sketch of Electro-Magnetism*, which appeared in the *Annals of*

Philosophy, N. S. vols. II. and III. Nearly the whole of that sketch was written in the months of July, August, and September, of 1821; and the first parts, to which I shall particularly refer, were published in September and October of the same year. Although very imperfect, I endeavoured, as I think appears on the face of the papers, as far as in me lay, to make them give an accurate account of the state of that branch of science. I referred, with great labour and fatigue, to the different journals in which papers by various philosophers had appeared, and repeated almost all the experiments described.

Now this sketch was written and published *after* I had heard of Dr. Wollaston's expectations, and assisted at the experiments before referred to; and I may, therefore, refer to it as a public testimony of the state of my knowledge on the subject *before* I began my own experiments. I think any one, who reads it attentively, will find, in every page of the first part of it, proofs of my ignorance of Dr. Wollaston's views; but I will refer more particularly to the paragraph which connects the 198th and 199th pages, and especially to the 18th and 19th lines of it; and also to Fig. IV. of the accompanying plate. There is there an effect described in the most earnest and decided manner, (see the next paragraph but one to that referred to,) my accuracy, and even my ability, is pledged upon it; and yet Dr. Wollaston's views and reasonings, which it is said I knew, are founded, and were, from the first, as I now understand, upon the knowledge of an effect quite the reverse of that I have stated. I describe a neutral position when the needle is opposite to the wire; Dr. Wollaston had observed, from the first, that there was no such thing as a neutral position, but that the needle passed by the wire: I, throughout the sketch, describe attractive and repulsive powers on each side the wire; but what I thought to be attraction to, and repulsion from the wire in August, 1821, Dr. Wollaston long before perceived to arise from a power not directed to or from the wire, but acting circumferentially round it as axis, and upon that knowledge founded his expectation.

I have before said, I repeated most of the experiments described in the papers referred to in the sketch; and it was in

consequence of repeating and examining this particular experiment, that I was led into the investigation given in my first paper. He who will read that part of the sketch, above referred to *, and then the first, second, and third pages of my paper †, will, I think, at once see the connexion between them; and from my difference of expression in the two, with regard to the attractive and repulsive powers, which I at first supposed to exist, will be able to judge of the new information which I had, at the period of writing the latter paper, then, for the first time acquired.

ART. X. *Proceedings of the Royal Society.*

The following papers have been read at the table of the Royal Society since our last report :

March 6. On a new phenomenon of electro-magnetism, by Sir Humphry Davy, Bart., P.R.S.

13. On fluid chlorine, by Mr. Faraday, communicated by the President.

20. On the motions of the eye in illustration of the muscles and nerves of the orbit, by Charles Bell, Esq., communicated by the President.

April 10. An account of an apparatus, on a peculiar construction, for performing electro-magnetic experiments, by Wm. H. Pepys, Esq.

On the condensation of several gases into liquids, by Mr. Faraday, chemical assistant, Royal Institution, communicated by the President.

17. On the application of liquids formed by condensation of gases, as mechanical agents, by Sir Humphry Davy, Bart., P.R.S.

On the temperature of the Sea at considerable depths, by Captain Sabine.

24. Details of experiments made with an invariable pendulum in various places on the South American station, by Captain Basil Hall, R.N.

May 1. On the changes of volume produced in gases in different states of density by heat, by Sir Humphry Davy, Bart., P.R.S.

His Grace the Duke of Northumberland was elected a Fellow of the Society.

8. Continuation of Professor Buckland's account of the caverns containing bones in England and Germany.

William, Earl of Dartmouth, was admitted a fellow of the society.

* *Annals of Philosophy*, N. S., ii. 198, 199. † *Quarterly Journal*, xii. 71—76.

15. Further remarks on the evidence of diluvial action in the caves of Germany, by Professor Buckland.

At this meeting Mr. William Clift was elected into the society.

29. Description of a magnetic balance, with an account of some recent experiments on magnetic attraction, by Mr. W. S. Harris, communicated by the President.

At this meeting of the society the following gentlemen were elected fellows: *viz.*, Peter Barlow, Esq., Arthur de Capel Brooke, Esq., J. S. Harford, Esq., the Rev. Lewis Evans, Samuel Reynolds Solly, Esq., and the Rev. J. M. Traherne.

June 5. A case of pneumato-thorax, with experiments on the absorption of different kinds of air introduced into the pleura, by John Davy, M.D.

On fossil-shells, in a letter to the President, by L. W. Dillwyn, Esq. John Rennie, Esq. was elected a fellow of the society.

12. On the existence of bitumen in certain minerals, by the Rt. Hon. George Knox, F.R.S.

On the diurnal variation of the horizontal magnetic and dipping needle, by P. Barlow, Esq.

19. On the diurnal deviations of the horizontal needle, when under the influence of magnets, by J. H. Christie, Esq.

Astronomical observations made at Paramatta, communicated by Sir T. Brisbane.

Contributions towards the history of the cocoa-nut tree, by H. Marshall, Esq.

An account of the effect of mercurial vapours on the crew of H. M. ship *Triumph*, in the year 1810, by W. Burnett, M.D.

On the apparent magnetism of metallic titanium, by W. H. Wollaston, M.D., V.P.R.S.

Tables relating to certain deviations which appear to have taken place in the north polar distance of some of the principal fixed stars, by J. Pond, Esq., F.R.S., Astronomer Royal.

Account of a case of pneumato-thorax, in which the operation of tapping the chest was performed, with some observations on the power of mucous membranes to absorb air, by John Davy, M.D., F.R.S.

Account of experiments made with an invariable pendulum at New South Wales, by Major-General Sir Thomas Brisbane, K.C.B., F.R.S., communicated by Captain Henry Kater, F.R.S., in a letter to the President.

Second part of the paper on the nerves of the orbit, by C. Bell, Esq.

On astronomical refractions, by J. Ivory, A.M., F.R.S.

On algebraic transformation, as deducible from first principles, and connected with continuous approximation, and the theory of finite and fluxional differences, including some new modes of numerical solution, by W. G. Horner, Esq.

Major-General Sir George Murray was elected fellow of the society.

The Society then adjourned over their long vacation, to meet again on Thursday, November 20.

ART. XI. PROGRESS OF FOREIGN SCIENCE.

1. *On the Cold produced by the Evaporation of Liquids.* By M. Gay-Lussac.

This memoir was read to the Academy of Sciences so long ago as 1815, but its publication was deferred, in the view of rendering it more complete; an intention which its author has not possessed leisure to realize.

The evaporation of a liquid may take place in a vacuum or in a gas. The depression of temperature, which results, differs in these two circumstances. In a vacuum, supposing the vapour to be absorbed as soon as it is produced, the greatest cold takes place for a determinate temperature of the ambient medium, when the caloric absorbed for the transformation of the liquid into vapour is equal to that entering the liquid from the sides of the receiver*. For it is evident that, since the latter augments with the difference of temperature between the liquid and the surrounding medium; and as, on the contrary, the elastic force of the vapour goes on continually to diminish, as well as its velocity, (of formation,) there must necessarily be a period, at which the caloric absorbed by the vapour shall be equal to the caloric poured in by the surrounding walls. But if we lower the temperature of the ambient medium, the limit of the cold will retrocede, and it may do so, even indefinitely, whilst the vapour of the liquid shall preserve an appreciable tension. Thus M. Gay-Lussac has frozen mercury with ease, by surrounding with a frigorific mixture of ice and salt, the vessels in which the aqueous vapour was produced and absorbed by the apparatus of professor Leslie; and he does not doubt, that, with analogous means, and very evaporable liquids, we may arrive at a degree of cold much more considerable than by the mixtures.

Suppose, now, that the evaporation takes place in a gas, perfectly dry, of a determinate temperature. Here new causes come to influence the production of the phenomenon, which it is necessary to appreciate.

In the first place, the evaporation is retarded by the gas, which presses on the liquid. It would amount to nothing, in a gas perfectly at rest, whose density, under the same pressure, would be equal to that of the vapour; and the temperature being supposed constant, it would augment nearly in proportion to the velocity of the gas, until this velocity was equal to that which the vapour would assume *in vacuo*. The cold produced by the vapour, depends on it, up to a certain point; for if it were very little, it would be possible, that the heating produced

* It is here supposed, that the evaporation takes place over the whole surface of the liquid, as with a thermometer with a moistened bulb. This is the most favourable case for obtaining the *maximum* of cold.

by the surrounding bodies, would be more rapid than the cooling due to the evaporation; and thus, the cold could not reach its limit.

In the second place, the liquid, evaporating only by means of the air, which impels against its surface, cannot evidently cool as much as *in vacuo*; and for a given initial temperature, the cold produced is at its *maximum*, when the caloric, absorbed by the vapour, is equal to that which the air loses, to put itself in an equilibrium of temperature and pressure with it, *plus* the caloric poured into the evaporating surface by the surrounding bodies; but the quantity of the latter, when the cold produced is only a few degrees, is small in comparison of the other, and may be neglected. From the latent heat of the vapour of the evaporable liquid, the law of its elastic force relative to the temperature and its density, on one hand; and, on the other, the capacity of the air for heat, its temperature, its density, and its pressure, M. Gay-Lussac has constructed a formula, for calculating the degree of cold, which should be produced by evaporation. In order to compare his theory with experiment, he determined directly the depression of temperature produced by a current of dry air on a mercurial thermometer, surrounded with moistened cambric. The air issuing from a gasometer, under a constant pressure, passed first through a tube filled with chloride of calcium; from this tube it entered another, where it met a thermometer destined to show its temperature; then five centimetres further on, (two inches E.,) another thermometer with a moistened surface, which it enveloped on every side. Thence, it diffused itself freely in the atmosphere, without suffering further change of pressure. The calculated and experimental results coincide very nearly. We shall content ourselves with giving the latter.

Temperature of the
dry air at the pres-
sure of 29.9 inches.

Depression of temperature pro-
duced by evaporation below
the temp. of the air.

0° C.	5.82° C.
1	6.09
2	6.37
3	6.66
4	6.96
5	7.27
6	7.59
7	7.92
8	8.26
9	8.61
10	8.97
11	9.37
12	9.70
13	10.07

Temperature of the dry air at the pres- sure of 29.9 inches.	Depression of temperature pro- duced by evaporation below the temp. of the air.
14° C.	10.44° C.
15	10.82
16	11.20
17	11.58
18	11.96
19	12.34
20	12.73
21	13.12
22	13.51
23	13.90
24	14.30
25	14.70

The heat given up by the air, during evaporation, depending evidently on its density, it follows, that, all other things being equal, the cold produced ought to increase as the density diminishes. We have hitherto supposed that the air was perfectly dried; but, if we take it in the ordinary hygrometric state, the cold produced by evaporation will not be so considerable, and it will be even null, where the air is saturated with humidity. The cold is relative to the quantity of water which the air can suffer to pass into the state of vapour; but this quantity is not immediately known, by that already contained in the air, before it arrives at the moist surface. Suppose, in fact, that the temperature of the air is 10° C., and that it is half saturated with humidity; suppose, further, that the cold produced amounts to 4°, it is evident that, at this term, the air which was half saturated with moisture at 10°, will be more highly so on account of the cooling which it has experienced, and that the quantity of water which can evaporate, is precisely equal to what the air wants at the temperature of $10^{\circ} - 4^{\circ} = 6^{\circ}$, in order to be saturated.

“In general, we may succeed in knowing the hygrometric state of the air, according to the cold produced by evaporation; but as this cold is variable with the pressure of the air, its temperature, its degree of humidity, we would require very extensive tables to determine it with exactness. I was willing to undertake this labour, repeating my experiments on the cold produced by evaporation, and making new ones; but I have been disheartened by its length, as well as the want of sufficient *data*, and especially by the consideration that the ingenious process of Leroi was susceptible of a more easy application, and that in the actual state of physics, it was much preferable.” We heartily concur in this preference of M. Gay-Lussac, which brings a strong additional argument in favour of Mr. Daniell’s hygrometer, founded on the principle of Leroi, and against Mr.

Leslie's, constructed on the other plan.—*Ann. de Chimie et de Physique*, xxi. 82.

2. *Memoir on the Density of Vapours*, by M. Cès. Despretz.

Although we can find no new facts in this paper, it deserves notice from the mode of investigation. The process followed for comparing the weights of gases, has never been applied to vapours, because it was foreseen, that, on taking the densities at the boiling points of the liquids, the contact of the cool sides of the balloon would cause a portion of vapour to be liquefied. It would not be so, if the experiments were made at the temperature of the surrounding bodies. We might then weigh vapours as we weigh gases. M. Despretz conceives himself to be the first person who has done this. We obtain, adds he, vapour perfectly pure, and at the actual temperature of the surrounding bodies, by fixing a stop-cock to a barometric tube, whose internal diameter is triple that of the ordinary tubes, and by introducing into this tube the liquid whose vapour we wish to weigh. We adapt a balloon to it, well exhausted of air; this is soon filled with vapour; an ordinary barometer is plunged into the same bath, so that we know the elastic force of the vapour weighed, by the difference of height of the mercury in the two tubes. Lastly, we judge if the elastic force is at the maximum, and consequently, if the space be saturated, by the inspection of a third barometer-tube. In this third tube, there is liquid in excess, which will not be the case with the tube which furnishes vapour to the balloon, except in so far as the mercury in it is at the same height as in the first.

We consider the suggestion of M. Despretz ingenious, but the details are obscure. A plate of his apparatus should have been given in the *Annales*.—*Ann. de Ch. et de Ph.* xxi. 143.

3. *On the Hydriodide of Carbon* (hydriodure;) *a new Mode of obtaining it.* By M. Serullas.

The preparation of the hydriodide of carbon, by the action of potassium on alcohol holding iodine in solution, being practicable by few persons, from the price of potassium, M. Serullas sought to obtain this new body by other and easier means. After different attempts, all founded on the re-action of bodies which could present nascent olefiant gas to iodine, M. S. has succeeded in readily procuring hydriodide of carbon. On chloride of iodine, made by saturating pulverulent iodine with chlorine in a globe, he poured from five to six times its weight of alcohol, at 34°, (about 0.847 sp. gr.) The liquid, at first turbid, became clear in a few instants with deposition of some saline matters proceeding from the impurity of the iodine, as also of a small quantity of an acid iodate having potash for its base, which likewise existed in the iodine.

This alcoholic solution of chloride of iodine being treated

with small portions of an alcoholic solution of caustic potash, there was instantly formed a very abundant yellowish, curdy precipitate, composed of a mixture of hydrochlorate and acid iodate of potash. The acid iodate, it ought to be observed, exists only at the commencement. The saturation being continued and pushed to a slight alkaline excess, the liquid, which was strongly coloured at a certain period of the saturation, by the separation of the iodine of the sub-chloride, appeared after some moments of repose above the saline deposit, of a lemon-yellow colour, having the saccharine taste given to it by the hydriodide of carbon, which it holds in solution, along with the hydriodate of potash. We decant and wash the salts several times with alcohol, to carry off the whole of the hydriodide; which is indicated by the alcohol ceasing to be coloured. The salts are set to drain on a filter, and the liquid is united to the other portions, after filtration. We evaporate the liquid at a gentle heat; the hydriodide crystallizes; and we separate it before the entire evaporation of the liquid, by throwing it on a filter and washing it with cold water, till this be no longer affected by nitrate of silver; a proof that the hydriodide is freed from the hydriodate of potash which it might have retained. We separate afterwards, by solution and crystallization, the hydrochlorate from the iodate, which we make use of, converting it into an iodide by fusion.

M. Serullas afterwards contrived the following modification of the process: Into alcohol of the above strength, mixed with much more iodine than it could dissolve, he passed a current of chlorine, which made the colour of the iodine speedily disappear, whose solution was meanwhile aided by agitation with a glass tube. The stream of gas having been continued some instants after the disappearance of the iodine, the yellowish liquor, considered to be then an alcoholic solution of chloride and sub-chloride of iodine, was saturated in the same way as the other, by an alcoholic solution of caustic potash, which immediately determined the formation of the same yellow curdy precipitate containing the same substances: iodate, hydrochlorate of potash, and hydriodide of carbon in solution; the last in as large a proportion as by the process of mingling alcohol with the chloride of iodine separately prepared. The acid-iodate of potash, which instantly falls down, from its insolubility in alcohol, has, like iodic acid, a sharp and astringent, but less intense taste than that of iodic acid. Its solution merely reddens, without destroying, tincture of litmus. This salt is less soluble than the neutral iodate of the same base; and its crystals, when slowly formed, present truncated pyramids, whose base is a rectangular parallelogram, or small prisms, with four very transparent faces, terminated by pyramid of four faces.

M. Serullas conceives that, without the concurrence of potash, the simple act of dissolving chloride of iodine in alcohol, is not sufficient to decompose the water, and produce hydriodide of carbon; for the existence of this hydriodide is not manifested till during the saturation, beginning, probably, at the moment when the iodine of the sub-chloride is set at liberty, and it is only when the saturation is completed, that the liquor acquires the yellow colour, the saccharine taste, and the peculiar odour, which distinguish the hydriodide. Saturation by pure magnesia produces no hydriodide. This compound is solid, of a lemon-colour, and a saccharine taste, which becomes very manifest when it is dissolved in alcohol. It crystallizes in spangles of a brilliant aspect. Its smell is aromatic, approaching nearly to that of saffron. Its specific gravity is nearly double that of water. It is not sensibly soluble in this liquid. It dissolves in 80 times its weight of alcohol of 0.825 sp. grav., at the ordinary temperature; and in 25 times, at a temperature of 95° Fahr. Seven parts of ether dissolve one of hydriodide.

Fat and volatile oils dissolve it readily. In the latter, at least in the essence of lemons, it suffers an alteration; for, on exposure to light, charcoal is evolved, and the iodine becomes free. Sulphuric, sulphurous, nitric, and muriatic acids have no action upon it; nor has a solution of chlorine in water.

Exposed to the air, at common temperatures, it disappears at the end of a certain period. A heat of 212° Fahr. volatilizes it without decomposition; between 240° and 248° it enters into fusion, and is soon afterwards decomposed, giving rise to vapours of iodine, a deposit of very brilliant charcoal, and hydriodic acid. A portion is volatilized at the same time. Of all the simple non-metallic bodies, chlorine, in the state of gas, is the only one which presents, with hydriodide of carbon, very remarkable phenomena.

These two bodies scarcely come into contact before there is a lively action, and sudden decomposition of the hydriodide; whence products result, whose nature varies according to circumstances.

1. If the chlorine, as well as the hydriodide, are perfectly dry, there is formed a chloride of iodine, some muriatic acid, and a peculiar white matter containing much carbon.

2. If the chlorine be in excess, there is a formation of a solid yellow chloride; and one of a subchloride in the opposite case.

3. When the quantity of chlorine which has been made to act upon the hydriodide has been sufficient merely to produce a subchloride, there is no longer found in its watery solution the above white matter, but small quantities of a liquid of an oily appearance, which seems to grease the sides of the vessels,

unites gradually at the surface of the water, and ends sometimes in falling down, and collecting at the bottom, in a drop more or less bulky. The vessels have then a very peculiar odour, approaching much to that of essence of turpentine.

M. Serullas at first imagined, that these two substances might be the chlorides of carbon discovered by Mr. Faraday; but he has not been able to recognise either of the properties by which Mr. Faraday distinguishes them, nor are those which characterize the peculiar matters, similar to those of the species of chloride of carbon, which may be obtained from the action of chlorine on alcohol. It is difficult, however, to believe that there is not an identity of composition between these products; which will be, no doubt, modified by circumstances which he has not been able to appreciate.

To make the experiment of transforming the hydriodide of carbon into the chloride of iodine, we fill a phial, having a ground stopper, with chlorine dried over chloride of calcium, and throwing into it some hydriodide in powder, immediately shut the phial; the action is speedy. There is a developement of heat and a brisk effervescence due, he thinks, to the disengagement of muriatic acid gas, which is formed. We see the liquid red sub-chloride which also is formed at the same time, successively pass, by the absorption of chlorine, into a solid yellow chloride. It is possible, by heating carefully the stoppered bottle, to make the chloride pass alternately from the solid state, to the state of a liquid sub-chloride, which, on cooling, returns to its primitive state by resuming the chlorine which the heat had separated with effervescence. M. Serullas has even employed this means to volatilize the chloride, from one side of the bottles to the other, across the residuary chlorine, in order to be sure of the complete decomposition of the hydriodide. When we project hydriodide of carbon into flasks filled with chlorine, we hear each time a slight noise, similar to that produced by the immersion of a red-hot iron rod in water.

4. If the chlorine employed in these experiments is still charged with the usual humidity which it has in coming directly into the bottles without previous drying, the hydriodide of carbon which we introduce equally gives rise to chloride of iodine, and muriatic acid, but we have no longer the white matter. There is formed in its place chloroxycarbonic gas (phosgene gas) which we can insulate by inverting the bottles first over a mercurial bath, to make the excess of chlorine be absorbed with agitation; then in water, in order to dissolve the muriatic acid. The phosgene gas can remain a sufficiently long time in contact with water without being decomposed, so as to be examined and recognised. This circumstance of the humidity of the chlorine, to which M. Serullas had not paid attention in his first experiments, hindered him, for some time, from recognising under what form

the carbon disappeared, which he knew positively to exist in the hydriodide.

He had occasion to observe, in these experiments, that the sub-chloride of iodine, treated by ammonia, threw down, at the moment, the iodine, in the state of a very fulminating iodide of azote; and that there was formed scarcely any hydriodate of ammonia. We can understand this, since the chlorine, which in this case decomposes the ammonia, ought exclusively to seize the hydrogen, leaving the azote to the iodine. By the common process of putting iodine into water of ammonia, only one-fourth of the iodine is converted into the fulminating compound.

The facility offered by chlorine, of converting the hydriodide of carbon into chloride of iodine, and consequently into iodate and hydrochlorate, by its solution in water, and saturation with potash, appeared to M. Serullas, after other trials, to be the most exact means of ascertaining the quantity of iodine which enters into the composition of the hydriodide of carbon. He treated a number of times with chlorine, given quantities of hydriodide of carbon; the resulting chloride of iodine, being dissolved in water, and saturated with potash, constantly produced the same quantities of iodate, at least with so slight differences, that we may indicate, without fear of deviating from the truth, 1.5 gramme as the mean product, for each gramme of hydriodide. The iodate of potash being formed of 77.54 acid and 22.246 potash; the iodic acid of 100 iodine and 31.927 oxygen; every gramme of hydriodide of carbon will then contain 0.8992 of iodine.

M. Serullas analyzed the compound also, by ignition with oxide of copper; from which he infers it to consist of,

Iodine	.	0.8992	1 atom
Carbon	.	0.0864	2 atoms
Hydrogen	.	0.0144	2 atoms.
1.0000			

Ann. de Ch. et de Phy. xxii. 172.

Supplementary to the above information, M. Seralllas has inserted in the same Journal a letter to M. Gay-Lussac, on the subject, in which he says, that he finds hydriodide of carbon may be very abundantly obtained, by simply treating an alcoholic solution of iodine with an alcoholic solution of caustic potash, or soda. The formation of hydriodide of carbon, in this case, proves very manifestly the decomposition of the water; just as the formation of an iodate with excess of acid, from the first instants of the saturation of a solution of chloride of iodine, seems to prove the pre-existence of iodic acid in the solution; and consequently to confirm its being a mixture of iodic acid and muriatic acid, as M. Gay-Lussac has said.

4. *On a Crystalline Matter formed in a Solution of Cyanogen.*
By M. Vauquelin.

A solution strongly impregnated with cyanogen, which M. Vauquelin had preserved in his laboratory during the preceding winter, presented a new phenomenon to him, which he had not leisure to examine in his first experiments. At the end of about four months, this solution, become of a slight amber hue, deposited orange-yellow crystals, the number of which increased for some time. When this deposition seemed to have ceased, he examined the crystals, as also the liquor which had produced them.

The latter had an amber colour, diffused a strong smell of hydrocyanic acid, was alkaline, at least it suddenly restored the colour of litmus reddened by an acid. It precipitated the sulphate of iron of a bluish green, which changed instantly to blue by the addition of a drop of sulphuric acid. It is not to be doubted therefore from these experiments that the solution of cyanogen was converted into hydrocyanate of ammonia. It contained likewise carbonic acid, for it precipitated lime water.

Let us next pass to the examination of the properties of the crystals of which we have spoken, and see if by means of their properties, we can come at their chemical composition. 1. These transparent crystals have an orange yellow colour, which yields a lemon-coloured powder; their form is dendritic; they have no marked taste or smell; they are almost insoluble in water; potash ley disengages nothing from them, nor does it dissolve them. The mixture of these crystals and potash gives no Prussian blue with sulphate of iron. Dilute sulphuric and muriatic acids make them experience no alteration.

Placed on burning coals, they volatilize, diffusing a white smoke, and a strong smell of hydrocyanate of ammonia; leaving a very small quantity of black matter, which can be nothing but charcoal.

Heated in a glass tube, closed at one end, into which he had introduced a slip of paper dipped in sulphate of iron, they presented the following phenomena: a little moisture soon appeared, the paper assumed a bluish colour; then a dull white matter sublimed, and there remained in the bottom of the tube only some black grains. When the tube was opened, there exhaled a strong odour of hydrocyanate of ammonia, and the slip of paper, when dipped into a feeble acid, took a very intense blue colour.

As to the white sublimate, it had neither smell nor taste; it was insoluble in water; placed on burning coals, it was reduced into smoke, having the odour of hydrocyanic acid. Its minute quantity did not permit a more detailed examination, but M. Vauquelin thinks it is of the same nature as the crystals, minus the humidity.

What is then the composition of these crystals? This question is not easily answered, especially when one has at his disposal only a very small quantity of material.

However, if we bear in mind that cyanogen formed of carbon and azote, when decomposed in water, gives birth to hydrocyanic acid, ammonia, carbonic acid, and charcoal, which precipitates; and that in the case under consideration, the same effects take place, with the exception of the precipitation of carbon, it will appear undoubtedly probable, that this carbon is united with a portion of the undecomposed cyanogen, and that it is thereby rendered insoluble; but in falling down slowly it has had time to combine with a small quantity of water, and to assume the crystalline form; effects due to the low temperature in which the cyanogen was exposed during the winter. If this be the case, we might call this substance *sub-cyanogen* or *proto-cyanogen*.

We consider this nomenclature highly objectionable, admitting the composition to be clearly made out, which it is not. Cyanogen and sub-cyanogen should, strictly speaking, be called deuto-carburet and trito-carburet of azote; from which name their composition would immediately be seen.—*Ann. de Chim. et de Phys.* xxii. 132.

5. Effects of Boracic Acid on the Acid Fluuate of Potash.

M. Zeise has made the observation that fluuate of potash, in which the acid was in excess, might be rendered alkaline, by a suitable addition of boracic acid. The first portion of acid added diminishes the acidity, the following additions make it disappear entirely, for litmus paper is no longer changed by it; and lastly, the saline solution took an alkaline character, and restored to the blue colour, litmus paper which had been reddened by the acid fluuate of potash.

A solution of litmus reddened by the boracic acid, was mixed with another solution of litmus reddened by the acid fluuate, and instantly a blue colour was developed; the same effects take place by substituting soda or ammonia for potash; and it is the same whether we employ water or alcohol to dissolve them.

Syrup of violets, reddened by the acid fluuate of potash, became blue by the addition of boracic acid, and a new quantity of acid rendered it green. Papers, stained with curcuma (turmeric) and Brazil wood, experienced analogous changes of colour; so that all the re-agents seem to indicate that alkali is separated from the acid fluuate of potash by the addition of boracic acid; or otherwise, that the fluoboric acid, which may be formed by means of the fluoric and boracic acids, saturates less alkali, than each of its components would neutralize alone.—*Ann. de Chim. et de Phys.* xxi. 22.

6. *On the Hydroxanthic Acid, and some of its Products and Combinations.* By Mr. Will. C. Zeise, Professor of Chemistry in the University of Copenhagen.

By a series of experiments on the mutual action of carburet of sulphur, potash, and alcohol, Mr. Zeise has obtained results which he regards as very remarkable.

Potash, or soda, dissolved in alcohol, may be neutralized by carburet of sulphur, although this liquid does not change litmus colour, and does not neutralize the alkalis in their dry state, or when dissolved in water. This phenomenon is owing to the formation of a peculiar acid, by the re-action of the carburet on the alcohol, which is determined by the alkaline body. This new acid contains sulphur, carbon, and hydrogen. It is probable that the first two elements united act in this combination the same part the cyanogen does in hydrocyanic acid; and that they exist in it, in a different proportion from what they do in the ordinary carburet of sulphur. He has given the name of *xanthogen* (derived from $\xiανθος$ yellow and $γεννω$) to this compound radical, because it forms combinations of a yellow colour with some metals; and he has named the new acid, the *hydroxanthic*, because it is endowed with all the properties of a perfect acid.

Very pure carburet of sulphur dissolves readily in the alcoholic solution of potash, and there instantly results a greenish-yellow liquid. This is easily observed by employing a solution of potash made in the cold before it has begun to turn brown. If, after having added enough of carburet to neutralize the solution, we expose it to a temperature approaching to 0°C. , it will not be long in yielding delicate crystals so abundantly, that we shall soon have a concrete mass. This dried quickly between folds of paper is the hydroxanthate of potash. It is also obtained by evaporation of the neutral liquid, *in vacuo*, along with sulphuric acid, or even by spontaneous evaporation; and also by precipitation by means of sulphuric ether.

The process which he has commonly employed for the preparation of the hydroxanthate of potash is briefly as follows:—He puts one part of very pure and well calcined potash into a glass bottle, having a ground stopper; he pours on it about 12 parts of alcohol, containing about 96 or 98 in volume of pure alcohol; he next digests the mixture at a temperature of about 20° or 24°C. , agitating it very often for two or three hours, and then filters the solution. Immediately afterwards he adds very pure carburet of sulphur, till the liquor no longer reddens turmeric paper; in order to be sure of which he puts in a little carburet in excess, that is, till a portion of the liquid poured into water throws up some oily globules. He now pours the liquid into a glass capsule with upright sides. When we employ an ordinary capsule, by reason of its great tendency to climb, it rises in

abundance above the edges of the vessel. The capsule is then put immediately under the receiver of an air-pump, and a partial vacuum is made. When it is judged that the excess of carburet of sulphur with a portion of alcohol has been removed, he introduces a vessel containing sulphuric acid, and sets the pump in full action. At the end of some time he withdraws the vessel with the sulphuric acid, and replaces it by another of the same, till there remains very little liquid in the vessel containing the salt. Then, some time after, adding a little pure sulphuric ether, he throws the mass on a filter; a little thereafter he presses it quickly between folds of paper, and finishes the desiccation under the air-pump receiver. In winter, or in case we have plenty of ice at our disposal, he thinks the preparation of this salt may be effected by simple refrigeration. Evaporation in the open air has this disadvantage, that a part of the salt commonly assumes a yellow colour, and then it yields a solution more or less milky. We must take care not to employ too concentrated a solution of potash in alcohol; otherwise we obtain almost immediately a congealed mass, and here it may happen that a trace of sulphuretted hydrogen shall be formed.

Hydroxanthate of Potash.—This salt crystallizes in needles; it is colourless and very brilliant; in the air, it becomes faintly yellowish; it has a peculiar smell; its taste, at first, extremely cooling, becomes sulphureous and pungent. It is extremely soluble in water, and yet it does not attract humidity from the air. When newly prepared it dissolves completely in alcohol, but less copiously than in water; sulphuric ether dissolves very little of it, and petroleum does not affect it. A solution of this salt becomes milky by contact of air, and at the same time slightly alkaline. Hence test-papers, which on leaving a solution of hydroxanthate indicated no free alkali, change colour in the space of some time in the air.

On pouring acetic muriatic, or sulphuric acid, even in a very concentrated state, on the hydroxanthate of potash, no effervescence takes place; but the latter two acids, diluted with four or five waters, separate from it a liquid which is heavier than water, and in aspect perfectly resembling an oil. This is the *hydroxanthic acid*.

Barytes water, muriate, or nitrate of barytes, muriate of lime, sulphate of magnesia and alum, form no precipitates in a watery solution of the hydroxanthate of potash; sulphate of zinc, nitrate or acetate of lead, deutochloride or deutocyanide of mercury, produce white precipitates. With sulphate, nitrate, or muriate of copper, it occasions a precipitate of a very beautiful yellow colour. Chloride of antimony, nitrate of bismuth, deutochloride of tin, protochloride of mercury, and nitrate of silver, form also with it precipitates, which are of a yellow colour.

The precipitates by nitrate of silver, or protochloride of mer-

cury, pass speedily from yellow to black; we can obtain even immediately black precipitates with these re-agents, if we employ very concentrated solutions. The precipitate by sulphate of zinc becomes slightly greenish on exposure to air. The others do not change their colour either in air or water. None of them effervesces either with the sulphuric or muriatic acid.

A solution of hydroxanthate of potash, very neutral, enclosed in a vessel which screens it from the action of the air, may be heated during half an hour at a temperature of 60° C. without losing its characteristic properties. But, if before heating it, we have rendered it alkaline by an addition of potash, it will soon acquire the property of precipitating the salts of lead black.

If we gradually heat the hydroxanthate of potash enclosed in a small retort, communicating with a receiver, from which a tube passes into a mercurial bath, the following circumstances take place: Before the temperature is raised beyond 60° C. the salt appears to undergo no change; when heated more strongly, it yields oleaginous vapours, fuses with a strong effervescence, producing abundance of gas and vapours, and is transformed into a mass of a blood-red colour. The vapours soon condense into a liquid, which has the appearance of oil. The red matter hardly changes its colour on cooling. On exposing this substance to a higher temperature than that at which it was produced, it enters anew into an effervescing fusion, blackening at the same time, and giving rise to much oil and a little gas. But, at the end of some time, the frothing ceases; and finally the mass, quietly melted, produces neither oil nor gas, even at a temperature not far from that of a cherry-red. On allowing the mass then to cool, it divides itself into two portions, of which the lower is manifestly crystalline, of a black grey, and a lustre almost metallic; whilst the upper layer, of a nearly black colour, has no crystalline texture. If the fire be pushed so as to keep the mass red for some time, it will not furnish the crystallized part. The gaseous product appears to be of the same kind during the whole course of the decomposition; the same holds true of the oily matter. The first is distinguished by an extremely strong odour of onions or leeks; but, in other respects, it comports itself (at least in trials with contact of water) like a mixture of carbonic acid gas and sulphuretted hydrogen.

Xanthic Oil.—This liquid is limpid, and of a yellowish colour. Its odour (which resembles neither that of carburet of sulphur nor sulphuretted hydrogen) is very strong, and adheres strongly and for a long time, to every body which has been impregnated with it. Its taste is at once saccharine and pungent. Water appears to dissolve it in very small quantity; alcohol, when diluted even to a great degree, dissolves it in abundance. The alcoholic solution is disturbed by a certain quantity of water; but, if not too much loaded with oil, it becomes clear, on the

addition of a greater quantity of water. Xanthic oil does not affect the colour of litmus or turmene; it acts in no manner on nitrate of lead; it does not cause a precipitate with muriate of copper. At the approach of a flaming body, it readily takes fire, burns with a bluish flame, and gives rise to much sulphureous acid, mingled undoubtedly with carbonic acid. Water is condensed on the sides of a bell-glass suspended over the flame.

The *red matter* is deliquescent; dissolves completely in water; the solution is at first reddish, but soon becomes yellowish-brown. It strongly reddens turmeric. Alcohol acts but slowly on this substance.

The watery solution of the red matter, recently made, precipitates the salts of lead red; but commonly the precipitate becomes soon black; the cupreous salts are precipitated of a black-brown*. It does not occasion a precipitate with the salts of barytes; but a solution of the nitrate of barytes is coloured yellow. It makes a lively effervescence with acids, giving rise to an odour of sulphuretted hydrogen mingled with that of carburet of sulphur,—and there are, at the same time, separated globules of an oleaginous liquid; but no precipitate of sulphur takes place. A slip of paper imbued with nitrate of lead, and then exposed to the gas disengaged by muriatic acid, is coloured partly black and partly red. When exposed to the air, the red matter passes a little towards yellow.

The *crystalline matter* speedily deliquesces, and it dissolves in water without leaving any residuum. The solution is of a very intense brown-black, so that, before diluting it to a certain degree, the liquid appears nearly opaque; it becomes turbid on contact of air; and sulphuretted hydrogen, as well as a little sulphur are disengaged from it by acids. The matter *treated with a red heat*, seems analogous to a mixture of sulphuret of potassium with charcoal.

Hydroxanthate of potash, thrown on a glass-plate, red hot, readily takes fire, and burns quietly with a bluish flame; but if we set fire to it at the point of the flame of a candle, it burns with much energy, emitting sparks extremely brilliant. This somewhat singular phenomenon is, probably, due to flocks of charcoal, formed and projected by a partial decomposition of the salt, when it is exposed to a very strong heat which penetrates into the interior of the mass.

M. Zeise has prepared hydroxanthates of soda and ammonia, with alcoholic solutions of these alkalis and carburet of sulphur; hydroxanthates of barytes and lime, with the carbonates of these bases and hydroxanthic acid. The hydroxanthate of lime may also be obtained, but with difficulty, in a state of

* The solution is in this respect very similar to that obtained, according to M. Berzelius, by digesting for a long time in the cold an aqueous solution of potash with carburet of sulphur; or by adding carburet of sulphur to a watery solution of hepar.—*Ann. de Ch. et de Phys.* xx. 243.

purity, by decomposing a very concentrated alcoholic solution of hydroxanthate of potash, with an alcoholic solution of chloride of calcium. He thinks it probable that the greater part of the precipitates, produced by decomposing the metallic salts with hydroxanthate of potash, are combinations of xanthogen with the metal of the salt employed. The precipitate from copper is not attacked either by sulphuric or muriatic acid, whether concentrated or dilute; nitric acid, however, (specific gravity 1.32,) dissolves it easily, with a production of gas, and a substance which has the aspect of fat, at first coloured greenish-yellow, then whitish-yellow. The xanthide of lead is prepared with nitrate of lead and hydroxanthate of potash; it is white, and falls down in flocks. Xanthic oil is given out on exposing these two xanthides to heat in a retort.

Hydroxanthic acid is liquid at common temperatures, and even under them; it has completely the appearance of a transparent colourless oil. Its specific gravity is greater than that of water. It does not combine with this liquid. On contact of air it is soon covered with a white opaque crust. When much divided among water, it is completely destroyed in a short time. Its smell is strong and peculiar. It has at first an acid taste, then a very strongly astringent and bitter one. It reddens powerfully litmus paper, but a portion of the red is not long in becoming yellowish-white. To obtain hydroxanthic acid we introduce the hydroxanthate of potash into a long and narrow glass; we pour into it sulphuric acid, diluted with four or five volumes of water, aiding the re-action by a gentle agitation; two or three minutes afterwards, we add to the milky mixture, at intervals of some seconds, from three to four volumes of water, so managing it that the new acid may collect into a single mass at the bottom of the vessel; then we add speedily fifty or sixty volumes of water. It remains now only to withdraw the water, and to pour on new portions as speedily as possible; to withdraw this, and so in succession, till the washings no longer affect a solution of barytes. Instead of sulphuric acid, we may equally make use of the muriatic.

Hydroxanthic acid dissolves very readily in a watery solution of potash, barytes, or ammonia; it expels carbonic acid from the carbonate of potash, giving birth to a salt which entirely resembles that obtained by neutralizing an alcoholic solution of potash with carburet of sulphur. With carbonate of ammonia it furnishes hydroxanthate of ammonia, with disengagement of carbonic acid. It decomposes, also, carbonate of barytes, forming hydroxanthate of barytes, which is very soluble in water and alcohol. The re-action is, in general, much more lively when the salifiable bases or their carbonates are introduced in the solid state, into hydroxanthic acid, covered

with a little water, than when we employ their solutions, which is undoubtedly owing to the insolubility of the hydroxanthic acid in water. Black oxide of copper, yellow oxide of lead, red oxide of mercury, each, when introduced into the hydroxanthic acid, under water, are quickly converted into xanthides, which nowise differ from those procured by precipitation. With oxide of mercury the action is very lively.

Hydroxanthic acid takes fire in the air instantly, on the approach of a burning body, occasioning a strong odour of sulphurous acid. When exposed to heat, in a suitable vessel, it is decomposed at a temperature much below that of boiling water; and there appear to be formed carburet of sulphur, and an inflammable gas. No odour of onions, or of sulphurous acid, is manifested.

Iodine was employed for ascertaining whether this new acid contained hydrogen, and the results show that it does. When iodine is introduced into newly-prepared hydroxanthic acid, covered with water, there is manifested instantly a lively action; the iodine is set in motion on the surface of the acid, and is dissolved. The acid becomes in part opaque, and is coloured at first yellow, then brown,—so that we have soon at the bottom of the vessel an oleaginous liquid of a red-brown; but, after a little time, the colour begins to disappear, and, in the space of some minutes,) provided too much iodine has not been added,) there results a liquid, oily, opaque, and faintly yellow. The watery liquor, which floats over the oleaginous liquid, is almost colourless; it is more or less milky,—but, by means of a filter, we obtain it perfectly limpid. When tried by the proper tests, this liquor is found to be a solution of hydriodic acid. The oleaginous liquid which remains, when we have treated hydroxanthic acid with a sufficient quantity of iodine, no longer yields xanthide of copper, with a sulphate of this metal. Comparative trials were made with carburet of sulphur, iodine, and water; the iodine combines with the carburet, colouring it violet; but, as might be presumed, no trace of hydriodic acid is produced.—*Ann. de Chim. et de Phys.*, xxi. 160.

7. *On a very beautiful Green Colour.* By M. Henri Braconnot.

M. Noel, who has a fine manufacture of painted paper at Nancy, sent M. Braconnot a superb green colour, known in commerce for some years, in order that he might analyze it. A manufacturer of colours at Schweinfurt was said to possess the sole secret of its preparation. Of all the methods tried by M. Braconnot to obtain this colour, the following succeeded best:—He dissolved six parts of sulphate of copper in a small quantity of hot water; and, on the other hand, he boiled in water six parts of arsenious acid, with eight parts of the potash of commerce,

till no more carbonic acid was expelled. He mingled, by degrees, this hot solution with the first, agitating constantly till the effervescence ceased; a dirty greenish-yellow precipitate fell in abundance. To this he added about three parts of acetic acid, (three parts of which saturated 0.45 of carbonate of lime,) or such a quantity as that there was a slight excess of it, perceptible to the smell after the mixture. The precipitate gradually diminished in size; and, at the end of some hours, there was deposited spontaneously at the bottom of the liquor (now colourless) a powder, somewhat crystalline, and of a fine green colour. He separated the supernatant liquid, which, by resting longer on the colour, might deposit oxide of arsenic, which would render it paler. He afterwards treated it with a large quantity of boiling water, to remove the last portions of arsenic, beyond what existed in combination. We must take care not to add to the solution of sulphate of copper an excess of arsenite of potash, because it would saturate, in mere waste, the acetic acid, which ought to be in slight excess in the mixture, without causing any very obvious effervescence in it. For this reason, it is proper, in general, to take a neutral arsenite of potash. It is true that a portion of the arsenious acid remains in the mother liquor; but this may be employed for the preparation of Scheele's green, commonly used for painted papers of an inferior quality. It appeared that, when M. Bracconot added to the mixture, before the fine green colour was pronounced, a small quantity of the latter ready formed, the production of it was more speedily promoted,—as a crystal, plunged in a saline solution, attracts the molecules similar to its own.

The process now described has been repeated on the great scale, and with some modifications, at the manufacture of M. Noel. An arsenite of potash was employed, which had been prepared with eight parts of oxide of arsenic instead of six. The liquors were concentrated. Some hours after the mixture, a pellicle, of a very rich green colour, formed at the surface. The whole being exposed to heat, a heavy powder fell down, which was washed with abundance of water, to free it from the excess of arsenious acid. The green thus obtained was magnificent; and several unprejudiced colourists judged it to be more powerful than that of Schweinfurt.—*Ann. de Chim. et de Phys.*, xxi. 53.

8. *On the Combinations of Chromic Acid with Potash.*

By M. F. Tassaert, fils.

This gentleman affirms that a solution of chromate of potash, whether neutral or alkaline, will not yield crystals of a neutral salt, which salt can exist only in solution; and that, in reality, the lemon-yellow salt, known in commerce under the name of

the *neutral chromate of potash* is a subsalt, for repeated washings and crystallizations do not deprive it of the property of restoring the blue colour to reddened litmus paper. In attempting to form the neutral chromate, he found that, when he employed a solution of chromate containing nitre, even in small quantity, this could be easily separated by adding to the liquors an excess of alkali. On subsequent concentration, the whole of the nitre crystallized in well-formed prisms, carrying down with it but a small quantity of chromate; whilst if we saturate first of all the solution of chromate, so as to make it neutral, and afterwards evaporate, since the salt thus formed and the nitre have nearly the same degree of solubility, they fall down together in crystals, and can no longer be separated: but the contrary takes place when the neutral chromate is converted into a subsalt, it thus becomes much more soluble, and lets the nitre form first.

This difference of solubility between the acid chromate and the subchromate of potash, is very well marked; for if into a saturated or nearly saturated solution of alkaline chromate, we pour some drops of acid, there is immediately formed an abundant deposit of acid chromate. To free the salt completely from nitre, he recommends it to be deflagrated with charcoal in a crucible; and afterwards to be dissolved, filtered, and crystallized. M. Tassaert analyzed the chromates of potash, by drying them for several days in a temperature of from 50° to 60° C., precipitating their acid by acetate of barytes, washing the barytic salt, and adding to the supernatant liquid, sulphuric acid in excess; evaporating and igniting the sulphate of potash. He thus found that the acid chromate, which is naturally formed in the neutral solution, is composed of

Chromic acid	67.40
Potash	32.60

while the alkaline salt consists of

Chromic acid	52.0
Potash	48.0

It is to be observed, that chromate of barytes begins to dissolve in water, the moment that we remove from it the whole of the acetate of barytes that it contains mixed with it: it then dissolves in sufficient quantity to colour yellow the filtered liquors. A single drop of acetate of barytes, mixed with the edulcorating water, stops the dissolving process, and renders the filtered liquid turbid. Water, with a little alcohol, equally prevents this solution.—*Ann. de Chim. et de Phys.*, xxii. 51.

9. *Analysis of different Limestones, by M. P. Berzelius, Ingénieur des Mines.*

After giving a table of analyses of French limestones, not fit

for water-mortars, which is of too little interest in this kingdom for us to copy, he next presents us with the following table of analyses of hydraulic limestones.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
Carbonate of lime	0.900	0.858	0.892	0.890	0.890	0.825	—	0.792	0.765	0.800	0.840
—magnesia	0.050	0.004	00.30	0.020	0.020	0.041	—	0.025	0.030	0.015	—
—iron . . .	—	0.062	—	—	—	—	—	0.060	0.030	—	—
Clay {	Silica . . .	—	—	—	—	—	—	0.065	0.116	0.170	0.100
	Alumina . . .	0.050	0.054	0.078	0.090	0.090	0.134	—	0.038	0.036	0.010
	Oxide of iron . . .	—	—	—	—	—	—	—	—	—	0.010
	Charcoal . . .	—	0.022	—	—	—	—	0.020	—	—	—
Water	—	—	—	—	—	—	—	—	—	0.010	—
	1.000	1.000	1.000	1.000	1.000	1.000	—	1.000	0.992	1.005	1.000

The first five are called moderately hydraulic; the last six very hydraulic.

No. (1.) Limestone of Vougy (Loire,) between Roanne and and Chaulieu; sublamellar, yellowish, full of ammonites, and other shells. It gives a very good lime, which sets in water. (2.) Limestone of St. Germain, (Ain,) compact, of a deep grey, veined with white limestone, lamellar, and penetrated with gryphites. It is employed at Lyons, for water-works. (3.) Limestone of Chaunay, near Macon; compact, in fine grains, yellowish-white; it is of the secondary formation, and is employed in the fabrication of a lime, which is hydraulic. (4.) Limestone of Digna (Jura); compact, penetrated with plates of limestone, and having imbedded a great number of gryphites, of a very deep grey. It produces lime which takes a good hold, and may be considered as hydraulic. (5.) Limestone, which accompanies the preceding, and which enjoys the same properties; compact, in grains nearly earthy, of a bright grey colour. (6.) Secondary limestone of Nismes (Gard); compact, yellowish-grey; yields a hydraulic lime, which passes in the country for being of excellent quality. (7.) Lime of Lezoux, (Puy de Dôme,) fabricated from a marly fresh-water limestone. It is called excellent. It produces an abundant jelly, with acids. (8.) Compact limestone, the locality of which is unknown. It gives a very good hydraulic lime. (9.) Secondary limestone of Metz (Moselle); compact, in grains almost earthy, of a bluish grey, more or less deep. The lime which it produces is known to be hydraulic. (10.) Marly limestone of Senonches, near Dreux (Eure et Loire); compact, very tender, crushes between the fingers, absorbs water very readily. It forms a paste with this liquid, nearly like clay, but it does not fall into powder, when calcined. This lime is very celebrated, and is much employed at Paris. (11.) Mixture of four parts of the chalk of Meudon, and one part of the clay of Passy, in volume, which M. Saint-Leger employs to make artificial hydraulic lime, in the manufacture of it, established near the military school. The government uses at present only the lime

of M. Saint-Leger, in the public buildings of Paris. An immense consumption of it was made last year, for the canal of St. Martin; it has been judged superior to the lime of Senonches, a superiority of which M. Berthier has convinced himself by experiments on the small scale. It is sold at the price of 60 francs the cubic metre.

M. Berthier enters into a pretty full account of the Roman cement of Parker and Wyatt of London. The following is his analysis of the English stone, from which, by a regulated calcination, and subsequent pulverization, it is formed :

Carbonate of lime . . .	0.657
————— magnesia . . .	0.005
————— iron . . .	0.070
————— manganese . . .	0.019
Clay { Silica	0.180
{ Alumina	0.066
Water	0.013
	1.000

Lime produced by the above.

Lime	0.554
Magnesia	0.000
Clay	0.360
Oxide of iron	0.086
	1.000

The English stone is compact, of a very fine grain, hard, tough, capable of taking a fine polish, and of a grey-brown colour. Its specific gravity is 2.59. It is said to be got in tubercular masses, in marls. There is a similar stone at Boulogne. M. Berthier thinks, that with one part of common plastic clay, containing no sand, and two parts of chalk in bulk, which corresponds to one part of clay to $2\frac{1}{2}$ parts of chalk in weight, a very good hydraulic lime could be made, which would set as speedily as the English. He acknowledges, however, that it is not probable we can obtain by mixtures, hydraulic limes which can acquire so great hardness and solidity as the natural mortar, because these qualities depend, not only on the composition of the substance, but also on its state of compactness. We can conceive, that the greater density a hydraulic lime possesses, which slakes without changing volume, the greater facility its particles will have to become aggregated, and the less shrinking will there be in its consolidation. Whatever, therefore, we may do, the artificial mixtures will be always lighter than the natural stones.

The following general inferences, which M. Berthier draws from some subsequent experiments, are important. A limestone which contains 6 *per cent.* of clay, affords a lime already per-

ceptibly hydraulic; when the clay is present in the proportion of 15 to 20 *per cent.*, the lime is very hydraulic; finally, the lime sets instantly, and may be regarded as Roman cement, when the limestone contains from 25 to 30 in the 100 of clay. He considers the iron and manganese as useless towards the hydraulic effect. To appreciate the qualities of a limestone, relative to the kind of lime which it can furnish, it is sufficient to determine the quantity of alumina and magnesia which it affords.

10. Observations on Mortars.

In a mortar which owes its solidity to the adhesion of the lime to the *alloys*, (the substances mixed with the slaked lime,) there is evidently an advantage in multiplying as much as possible the surfaces of contact, and consequently in employing a pulverulent alloy; but, the mortar in that case requires a larger proportion of lime than when we take a granular alloy. On the other hand, the alloys with large grains do not afford mortars so solid as the pulverulent alloys, because there remain among the grains of the alloy spaces filled with pure lime, which do not present the same resistance to fracture as the parts occupied by the alloy. It thus appears evident, that to obtain with the smallest possible quantity of lime, mortars which shall possess the *maximum* of solidity, we must employ alloys which contain particles of different sizes and pulverulent parts, avoiding always the mixture of argillaceous substances, which can form a paste with water, and which of themselves possess no coherence. M. de Saint-Leger made last summer trials on the great scale, the results of which coincide perfectly with these views. He found, contrary to the common opinion, that the sand usually employed at Paris, gives a better mortar, when it is merely washed, than when the fine particles are separated by means of a sieve.

The pozzolanas, both artificial and natural, differ extremely in their composition; they resemble one another only in the power they possess of absorbing water without softening; a power due to their porosity. It is probable, therefore, when they act on lime in a peculiar manner different from other alloys, such as quartzose sand, pounded glass, &c., it is to their porosity, as M. John imagines, that they owe this property. The important observation made by M. Vicat, that clay slightly baked is an excellent alloy, whilst the same substance strongly calcined is a very indifferent one, supports the same opinion; for clay slightly baked, and that strongly calcined, differ from each other only in this, that the first is light, porous, and capable of absorbing water, whereas the last has become compact and altogether similar to a stone, by the effect of its contraction, which the high temperature has caused it

to undergo. In other respects they are both in quite another state from raw clay, since they do not contain combined water, and can no longer form a paste with this liquid.

It is known that porous bodies have the faculty of absorbing and condensing rapidly a great number of gaseous substances. May it not be, because they act in this manner on the carbonic acid contained in the atmosphere and in water, that they have the property of accelerating the condensation of certain mortars? We may thus conceive why they produce this effect with a rich lime, whilst with poor or very hydraulic limes, they give no better result, than non-porous alloys; for, the mortars of rich limes owe their solidification only to the regeneration of carbonate of lime, while the solidification of the mortars of very hydraulic limes is independent of this cause.

To the above remarks we may add, that the English stone, from which Roman cement is made, is a ferruginous marl, in spheroidical concretions, called *septaria* or *ludi Helmontii*; a description of which is to be found in our common chemical works.—*Ann. des Mines*.

11. *Analytical Examination of Touch-stone.* By M. Vauquelin.

This stone, *lapis lydius*, is usually arranged in the works on mineralogy, in the sequel of the Cornéennes stones, without being entirely confounded with them. (It is the schistous jasper of Brogniart, and a sub-species of rhomboidal quartz of Mohs.) The specific gravity of the touch-stone of M. Vauquelin is 2.465. It whitens before the blow-pipe, exhaling a feeble sulphurous acid odour. The fragments which before calcination are crushed on glass, afterwards scratch it easily. It has no action on the magnetic needle. Acids in the cold exercise no perceptible action on a mass of touch-stone; but, if we heat muriatic acid on the mineral reduced to a fine powder, there is instantly disengaged a very manifest odour of sulphuretted hydrogen; a little iron is dissolved, and the acid becomes yellow. The residuum, which is considerable, seems to have become blacker by this operation.

The alkalis easily dissever the principles of touch-stone. With potash the fusion, at a red heat, is easy and very liquid, like that of siliceous stones. The mass becomes of a greyish-yellow. M. Vauquelin satisfied himself by means of ignition with chlorate of potash, that the black colour is owing to carbon; the quantity of which he determined from the volume of resulting carbonic acid. From the smell evolved by the action of potash on the mineral, he infers the presence of a small quantity of ammonia in it; which seems to be in the state of a muriate. He could not estimate its amount. The presence of sal-ammoniac, charcoal, iron, and sulphur, says

M. Vauquelin, may put geologists in the way of imagining the origin and mode of formation of this singular mineral production. The discovery of a quantity of this stone, of good quality, would be of great importance, adds he, to the goldsmiths; for it is rare, and extremely high priced.

Analysis.	First Specimen.	Second Specimen.
Silica	85.00	69.00
Alumina	2.00	7.50
Lime	1.00	a trace —
Charcoal	2.70	3.80
Sulphur	0.60	a trace —
Metallic iron	1.70	17.00
Moisture	2.50	97.30
Loss	4.50	
	100.00	

Ann. de Chim. et de Phys. xxi. 317.

12. *Examination of an Aërolite which fell in the neighbourhood of Epinal on the 13th Sept. 1822, at the entrance of the forest of Taunière, three quarters of a league from la Baffe (Vosges.)* By M. Vauquelin.

This stone is in appearance like the ordinary aërolites; but is distinguished by the great quantity of metallic iron, and the small quantity of sulphur that it contains. By acting on its powder, with muriatic acid, and transmitting the evolved gas, through solution of acetate of lead, slightly acid, he had a precipitate of sulphuret of lead; from whose quantity he inferred that of the sulphur present. What was insoluble in muriatic acid, he washed on a filter, and afterwards calcined with caustic potash. The fused matter assumed a greenish tint. The muriatic solution was treated with gaseous chlorine, to peroxidize the iron, which was then thrown down with ammonia. From this precipitate, he separated the manganese and the minute quantity of magnesia, which might fall along with it by sulphuric acid. The following are the results on four grammes:

		In 100 parts.
Silica	1.40	35.00
Oxide of iron	2.51	62.75
Sulphur	0.09	2.25
Oxide of chromium .	0.01	0.25
— nickel	0.02	0.50
Magnesia	0.17	4.25
Lime and potash . .	0.50	1.25
	4.70	106.25

The 2.51 parts of oxide of iron correspond to 1.76 of metal;

but the 0.09 of sulphur require 0.16 of metallic iron to form a proto-sulphuret; and if we deduct besides 0.18 for the 0.25 of oxide of iron, obtained from the chromate, there will remain 1.42 of metallic free iron, containing only the nickel and the manganese. Of the fall of the above aërolite, some account is given in this Journal. xiv. 448.—*Ann. de Chim. et de Phys.* xxi. 324.

CHEMISTRY OF ORGANIZED BODIES.

13. *Analysis of the Fruit of Areca Catechu.* By M. B. Morin, Apothecary.

The tree called areca catechu by Linnæus, grows abundantly in the Molucca isles, in Ceylon, and several other of the southern countries of Asia. Its constituents are; 1. Gallic acid; 2. A large quantity of tannin; 3. Acetate of ammonia; 4. A peculiar principle analogous to that found in the leguminous plants; 5. An insoluble red matter; 6. A fatty matter, composed of elaine and stearine; 7. Volatile oil; 8. Gum; 9. Oxalate of lime; 10. Ligneous fibre; 11. Mineral salts; 12. Oxide of iron and silica. *Journ. de Pharm.* Oct. 1822. p. 455.

14. *On the Action of Flowers on Air, and on their Temperature.* By M. Theodore de Saussure.

The flowers, even of aquatic plants, do not develop themselves in *media* deprived of oxygen gas; they require for the support of their vegetation a greater proportion of this gas than the rest of the plant. The green parts are often so abundant in the leaves, that they can of themselves form the atmosphere necessary to their existence; but it is not so with the flowers.

Several among them, as the rose, preserve, it is true, their corolla for a shorter time in the air than in vacuo or in azotic gas; but, when we expect to withdraw them still fresh, they exale an unwholesome smell, their petals are corrupted, and we perceive that this apparent life concealed a real death, while the fall of the blossom in the air is only an effect and a proof of vegetation.

When we place a flower under a receiver full of air, and shut by mercury, it changes little or nothing the volume of the air, while oxygen is present. It absorbs this gas, replacing it by a nearly equal volume of carbonic acid; *nearly*, because occasionally there is observed in the air, a slight diminution of volume, owing to porous absorption. M. de Saussure has not been able to find any trace of hydrogen in the air in which flowers have vegetated. His first trials made him imagine that they exhaled a small quantity of azote; but he has not confirmed this result. In estimating the quantity of oxygen destroyed by flowers, he weighs the latter, and takes their specific gravity as equal to that of water. The volume of oxygen consumed, is referred to

the volume of flowers or leaves taken for unity. Thus the number 8.5, which expresses in the table, the quantity of oxygen gas destroyed by the *Tropæolum majus*, denotes that a cubic centimetre, or a gramme weight of these flowers (deducting the peduncles), destroyed $8\frac{1}{2}$ cubic centimetres of oxygen gas, which were replaced by $8\frac{1}{2}$ cubic centimetres of carbonic acid, in 200 cubic centimetres of air. The duration of the experiments, or the abode of the flowers and leaves under the receiver, was 24 hours. All the following results were obtained in summer, sheltered from the direct action of the sun, at a temperature between 18° and 25° cent. The quantity of oxygen destroyed by the flowers, is greater in the sun than in the shade; a rise of temperature also augments this destruction. He has inscribed on the table, the hour when the flowers were plucked, and placed (with their stalk in a very little water) under the receiver; this period is especially important for those which blow but a short time, and which expand only at a certain time of the day, as the *hibiscus speciosus*, *cucurbita melopepo*, and the *passiflora serratifolia*. Only flowers, entirely developed, and in perfect vigour, were submitted to experiment; characters which are recognized particularly by the *stamina*.

Names of the Flowers.	Oxygen gas consumed by the flowers.	Oxygen gas consumed by the leaves.
Single gilliflower (red) Cheiranthus incanus, 6 in the evening.	11.	4.
Double gilliflower, <i>idem</i> .	7.7	
Single tuberosa (Polyanthes tuberosa) 9 A. M.	9.	3.
Double tuberosa. <i>Idem</i> .	7.4	
Troæpolum majus (single) <i>idem</i> .	8.5	8.3
Double ditto. <i>idem</i> .	7.25	
Datura Arborea 10 A. M.	9.	5.
Passiflora serratifolia, 8 A. M.	18.5	8.5
Carrot, (umbels of) Daucus carota, 6 P. M.	8.8	7.5
Hibiscus speciosus, 7 A. M.	8.7	5.1
Hypericum Calycinum 8 A. M.	7.5	7.5
Cucurbita melo-pepo (male flowers) 7 A. M.	12.	6.7
Ditto. (female flowers,) <i>idem</i> .	3.5	
White lily, 11 A. M.	5.	2.5
Typha latifolia 9 A. M.	9.8	4.25
Fagus Castanea, 4 P. M.	9.1	8.1

The results here given indicate that in equal volume the flowers usually destroy more oxygen than the leaves in obscurity, or than the rest of the plant; for the leaves destroy much more than the stems and the greater part of fruits. The differ-

ence is more striking, and subject to fewer exceptions, as we shall show further on, if we consider in the flower merely the stamina. A single genus of flowers, that of the arum, has presented a phenomenon very worthy of attention, by a production of *heat* hitherto unknown.

15. *Examination of the Excrements of Serpents, exhibiting in Paris, of the Boa Species.* By M. Vauquelin.

His experiments prove, that the excrements are merely uric acid without any mixture, except a little ammonia, potash, and animal matter; and are consequently produced from the urine like that formerly discovered in the excrements of birds. But the true excrements of the serpents are not of the same nature as those now spoken of; for others were given him only of feathers slightly changed, and bones become very brittle and deprived almost entirely of their gelatine; which proves that feathers, that is the horny texture, is, of all animal matters, the most difficult to digest.

The first species of excrement issues from the body of the animal, in the form of a pap, resembling chalk or starch diffused in a little water. Sometimes they come forth in a concrete mass, like a calculus. This proves that the urine of serpents dwells, like that of birds, in a sort of reservoir, called *cloaca*, where it is inspissated.—*Ann. de Chim. et de Phys.* xxi. 440.

ART. XII. ANALYSIS OF SCIENTIFIC BOOKS.

- I. *An Elementary Introduction to the Knowledge of Mineralogy; comprising some Account of the Characters and Elements of Minerals; Explanations of Terms in common use; Descriptions of Minerals, with Accounts of the Places and Circumstances in which they are found; and especially the Localities of British minerals.* By WILLIAM PHILLIPS, F. L. S., M. G. S., L. & C. &c. &c. &c. Third edition, enlarged.

THE third edition of this work has just made its appearance, and we congratulate the mineralogical public on the acquisition. The merits of the two former editions, (especially the second), have stamped a character on the book, that nothing we can say in its praise, can enhance, and have rendered its plan and contents so familiar to the cultivators of mineralogy, that it would be superfluous to attempt, in this place, a detailed account of them. Taking it for granted, therefore, that few mineralogists, who understand English, are unacquainted with the second edition, we shall proceed to show in what respects the present differs from its precursors, and point out the alterations, additions, and improvements, which its indefatigable author has introduced into it.

For this purpose, we shall begin by quoting some passages from the *Advertisement*, prefixed to this third edition.

The most important additions and improvements that have been made, consist, first, in the introduction of notices or descriptions of about eighty minerals, of which the greater part have been discovered since the publication of the preceding edition; secondly, in the insertion of the results obtained by a careful examination of most crystalline minerals, as regards their structure and cleavage; thirdly, in the addition of a figure to the verbal description of most substances found in a crystallized state, representing the primary form, and another the secondary planes in connexion with those of the primary crystal, together with such measurements of the planes as I have been able to obtain, chiefly by means of the reflective goniometer of Dr. Wollaston; in the fourth place, advantage has been taken of a translation of Berzelius's excellent work on "The use of the Blowpipe in chemical analysis, and the examination of Minerals, by J. G. Children, F. R. S., L. and E., &c." in so far as relates to the more simple experiments with that useful assistant to the student, in recognising minerals; and, fifthly, the meanings of the names by which minerals are commonly known in this country, are mostly given at the foot of the page, containing the description, except where, being chemical, they manifestly have been derived from the composition of the substance.

In regard to arrangement, no alteration has been made in this edition, except where new and more satisfactory analyses demanded a change: on the subject of the arrangement therefore, it seems requisite only to add that, having in the first instance adopted it, as being in my own estimation the most advantageous to the student that I could devise, the experience of its utility now induces me to recommend it to him as an instructive method of placing the minerals in his cabinet.

In this advice, we fully concur, and we believe that the mode of arrangement recommended by our author, has already obtained very general adoption. Since it is a consideration of

primary importance, we shall briefly state its outline, as, notwithstanding our conviction that the work is in the hands of almost every mineralogist, there may be one or two unacquainted with it; and to such, if such there be, the statement *must* be useful.

The basis of the arrangement is chemical, and since certain substances are found to occur in very large proportion in those rocks which, geologically, are usually considered to be of the oldest formation, the close alliance between geology and mineralogy suggests the *order*, in which each class of minerals may be taken.

Some of the earths chiefly constitute those rocks which are esteemed to be of the oldest formation; while others do not enter into the composition of rocks, being found only in the veins which traverse them; these, therefore, (as veins are considered of posterior formation,) may be estimated as being of later origin than the former.

Of the alkalies and acids as mineral constituents, either combined with the earths or with each other, the former claim the precedence, as entering into the composition of the oldest rocks.

Two or three of the metals occur in small quantity in the masses of some of the earlier rocks; but in general the metals are found in veins; some in veins traversing the older rocks, and rarely or never in those of a newer kind; others most abundantly, or only in those of newer formation.

As rocks are constituted chiefly of earths, and metals are principally found in veins, earthy minerals may be assumed to be of earlier origin than the metalliferous.

Proceeding according to this assumed relation in the respective ages of the mineral elements, and beginning with the most simple, and ending with the most compound substance, our author places silica at the head of his list, "because it is estimated that silex forms the largest proportion of the oldest and most abundant of the primitive rocks; and all earthy minerals, of which silex is the largest ingredient, are arranged under that head; beginning, chemically, with silex in its purest forms, and proceeding to such as consist of that and another earth, as silex and alumine; then to those consisting of silex and lime, &c.; and afterwards to such minerals as are chiefly constituted of three or more earths, terminating with the most compound; and regarding the iron, manganese, &c., involved in many of them only as accidental ingredients;" because they do not alter the external form, and internal structure of those minerals.

The other earthly minerals are proceeded with in like manner; arbitrarily selecting such as contain the rare earth glucine, and placing them under that head, except that the gadolinite, which also contains the still more rare earth yttria, is placed under the latter.

Next after those minerals which consist only of one or more of the earths, succeed those in which one or other of the alkalies is found; to these, such of the acids as occur in the concrete state; then those minerals which are primarily constituted of one or more earths and an acid; and, after these, those consisting of an alkali and an acid; and, finally, the very few in which an earth, an alkali, and an acid are combined together.

Then follow those minerals (chiefly earthy) which have not been analyzed, or of which but little is known.

The native metals and metalliferous minerals succeed, arranged according to the order of age and formation; subordinately beginning with the

metal in its native state, when it so occurs ; then its combination with other metals, when in the state of a natural alloy ; then combined with sulphur ; with oxygen ; and, finally, as an oxide combined with an acid.

The combustibles follow, beginning with sulphur, to which succeeds carbon in its purest form, and afterwards its several combinations with other bodies, as the base of the greater part of all the substances belonging to this class.

The order of arrangement is therefore as follows :—

Earthy minerals.

Alkalino-earthly minerals.

Acids.

Acidiferous earthy minerals.

Acidiferous alkaline minerals.

Acidiferous alkalino-earthly minerals.

Minerals (chiefly earthy) which have not been analyzed, or of which but little is known.

Native metals, and metalliferous minerals.

Combustibles.

In our opinion, this is at once the clearest and best arrangement hitherto suggested. Founded on the only rational basis, composition, it is so skilfully subdivided, that no confusion exists in any part of it. In point of convenience, too, in cases of hasty reference, the essential elements of any mineral are seen instantly by casting the eye on the running title at the top of the page, where its description occurs. It is hardly necessary to insist on the superiority of the preceding arrangement to that abominable violation of all chemical truth, which has placed crystallized carbon at the head of the earthy minerals !

With respect to the figures of the crystalline forms which accompany the descriptions, and which are neatly and accurately executed in outline on wood, Mr. Phillips informs us, that the measurements annexed to them are to be considered only as approximations to their true value, especially of the secondary planes ; “ for in no instance has it been attempted to correct the geometry of nature by a resort to the more rigid laws of calculation. It has been ascertained, by a comparison of the measurements taken from similar and brilliant planes of different crystals, that, owing to some natural inequality of surface, the same precise angle is rarely obtained, and hence those given in the succeeding pages cannot be expected to be absolutely exact.” The error, however, rarely exceeds forty minutes, and is frequently not more than one or two minutes ; and when the measurements of the primary form have been obtained from cleavage planes, (which is noted in the descriptions,) “ they may be considered as approximating the truth much more nearly than when taken by means of the natural planes.”

Where the regular solids, as the cube, regular octohedron, &c., are the primary forms, our author has adopted the measurements given by Haüy, and denotes them by the letter H annexed ; but, where the primary form is not one of the regular geometrical solids, as the oblique, and doubly-oblique prisms, and the very numerous class of rhombic prisms, he has determined their true measurements by “ subjecting the planes obtained by cleavage to the re-

flective goniometer—a more certain method than that adopted by Haiiy ;” who always, we believe, used the goniometer invented by Corangean.

In regard to the figures to which the measurements are annexed, it may be observed, that these are not in all cases the representatives of single crystals, for in some of them are associated the planes observed on two or three : thus occasionally rendering the form more complicated than any single crystal I have seen, but not more so than may probably be found hereafter. This mode has been adopted as offering to the student the greatest assistance that I could devise, since it combines at one view all the observed planes, without increasing enormously the bulk, and consequent expense of the work, as must have been the case if all the varieties of form had been given separately.

We had some doubts, on first reading the preceding passage, whether this assembling of planes from different crystals into one sum total may not rather tend to perplex, than instruct the student. On further reflection, however, we are inclined to think our author is right, since a reference to the simpler forms, including the primary, of which a series of smaller figures generally accompanies the larger, will sufficiently elucidate the more complex, and, in some degree, imaginary, yet still possible, structure ; and, in some instances, the planes on an actual crystal are so numerous, that nearly all that are represented on the large figures are discernible. Thus our author mentions a crystal of fluor, from Devonshire, in his own possession, which exhibits all the planes, except four, represented in the elaborate, and beautifully-distinct figure given at page 170, and would, if perfect, be bounded by 322 planes. If the figure we have just referred to was drawn by no “other rule than such as the hand and eye could furnish,” as our author tells us the figures generally were, his hand and eye possess a skill and accuracy very seldom indeed to be met with.

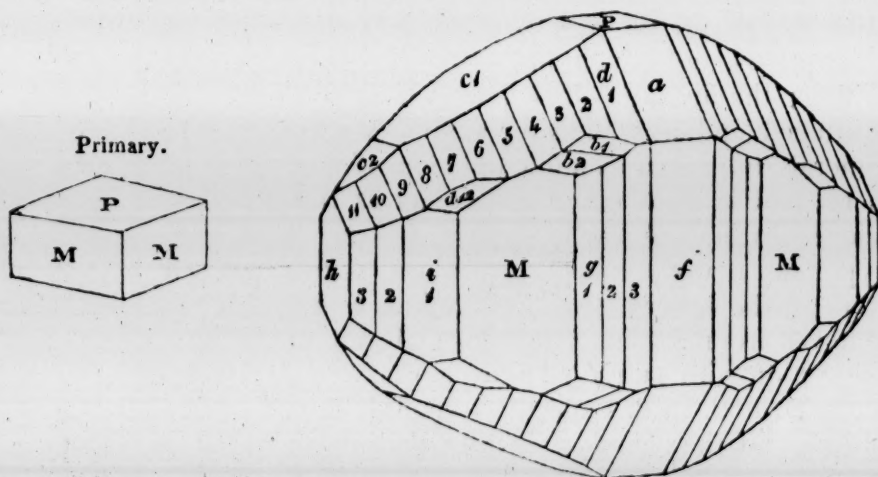
In the useful introduction which precedes the mineralogical descriptions, not much alteration has been made in the present edition ; the division which relates to analysis has been somewhat shortened, and, as well as the summary account of the elements of minerals, improved by a few judicious changes in point of arrangement, and in such other particulars as the progress of chemical science during the last four years has rendered necessary. The hypothetical wodanium is, of course, struck out altogether, and amongst the other essential alterations we are glad to see selenium removed from the list of metals, and restored to its more proper association with sulphur, phosphorus, and boron. Mr. Phillips remarks, both in this and the second edition, that we have no description of the iron pyrites from Fahlun, in which this substance is found. If it have any decided external characters, by which it may be distinguished, it is very desirable that they should be published, for we strongly suspect that many a specimen of common pyrites is sold as *seleniferous*, which does not contain an atom of selenium. We have ourselves witnessed, more than once, a lively competition for the purchase of such a specimen, said to be from

Fahlun, between two or three ardent collectors at an auction, till the price of the precious lot ran up enormously; whilst, from its perfect resemblance to some we had once an opportunity of examining, we felt confident, that it was quite guiltless of concealing a particle of selenium in its whole composition. The pyrites usually said to be seleniferous, is of a bright yellow colour, a small grain, and generally very friable.

As a specimen of the elaborate figures which accompany many of the descriptions, we annex a copy of that which Mr. Phillips has given of Humite*. We have selected this mineral for our purpose, because,—1st., its form has never been described before. 2dly, Count Bournon, in his Catalogue, says that all its planes are striated, whereas not one of them is so; for what he mistook for striæ, are, in fact, so many planes, as has been proved by subjecting the crystals to the reflective goniometer. 3dly. It shews, therefore, the value of that instrument in a striking degree, and that the use of it quickens the sight of the observer, who, while measuring without a glass, finds planes, where an old, and generally supposed accurate, observer saw only striæ.

HUMITE.—Bournon.

It occurs in very small crystals, which are of a deep reddish-brown colour, and transparent or translucent, with a shining lustre. The crystals are modified in an extraordinary degree; their primary form may be considered as being a right rhombic prism, of 60° and 120° , but they yield to mechanical division, parallel only to its shorter diagonal: (*i. e.*, to the plane *h* of the following figure.)



* Humite. In honour of Sir Abraham Hume.

M on M	120 00	$\overset{\circ}{h}$ on $\overset{\circ}{d}$ 4	119 24	$\overset{\circ}{h}$ — $\overset{\circ}{i}$ 2	140 56
P on M or M	90 00	— $\overset{\circ}{d}$ 5	121 45	— $\overset{\circ}{i}$ 3	143 20
— $\overset{\circ}{f}$ or $\overset{\circ}{h}$	90 00	— $\overset{\circ}{d}$ 6	125 30	$\overset{\circ}{c}$ 1 on $\overset{\circ}{d}$ 1	155 2
M on $\overset{\circ}{h}$	120 00	— $\overset{\circ}{d}$ 7	129 46	— $\overset{\circ}{d}$ 5	159 10
— $\overset{\circ}{d}$ 1	118 12	— $\overset{\circ}{d}$ 8	121 20	— $\overset{\circ}{d}$ 7	159 30
or M or $\overset{\circ}{f}$	150 00	— $\overset{\circ}{d}$ 9	124 2	$\overset{\circ}{d}$ 1 on $\overset{\circ}{g}$ 3	116 25
P on C 1	144 1	— $\overset{\circ}{d}$ 10	136 16	$\overset{\circ}{d}$ 12 on $\overset{\circ}{d}$ 8	163 22
— $\overset{\circ}{c}$ 2	153 45	— $\overset{\circ}{d}$ 11	157 20	— $\overset{\circ}{g}$ 3	131 15
$\overset{\circ}{h}$ on $\overset{\circ}{a}$	90 00	— $\overset{\circ}{g}$ 3	100 40	$\overset{\circ}{b}$ 2 on $\overset{\circ}{g}$ 3	143 15
— $\overset{\circ}{d}$ 1	101 50	— $\overset{\circ}{g}$ 2	103 40	$\overset{\circ}{b}$ 1 on M	137 00
— $\overset{\circ}{d}$ 2	103 42	— $\overset{\circ}{g}$ 1	115 15	$\overset{\circ}{f}$ on $\overset{\circ}{a}$	115 10
— $\overset{\circ}{d}$ 3	112 45	— $\overset{\circ}{i}$ 1	133 36		

It is found on Somma, with brownish mica.

The letters on each plane of the larger figure are placed according to the *system of notation* adopted by Mr. Brookes in his *Familiar Introduction to Crystallography*, of which we propose to give our readers an account in our next number. In the mean time we fully agree with Mr. Phillips in "recommending it strongly to the student, as being calculated to teach the interesting science on which it treats in its most pleasing form;" and we will add, as ably as pleasantly.

We should do our author injustice, if we were not to mention that the verbal description of the Humite is much shorter than the generality of the descriptions contained in the work. The hardness, specific gravity, chemical composition, and the principal characters of each substance before the blow-pipe, are, in most cases, carefully stated; and that they have been omitted in the description of Humite, is owing, we conclude, partly to its scarcity, and partly because it occurs only in minute, and, usually, separate crystals, wherefore the two first characters are hardly attainable, and we are not aware that any accurate analysis of this mineral has hitherto been made.

As only one plane of cleavage has yet been noticed, the primary form has necessarily been deduced from the nature and direction of the secondary planes, which, although perfectly consistent with the right rhombic prism, (the primary form adopted by Mr. Phillips,) are equally compatible with the assumption of a right rectangular prism for the primary form, in which case P, $\overset{\circ}{f}$, and $\overset{\circ}{h}$, would be the primary planes.

The utility of connecting the primary and secondary forms, as is done in a variety of instances throughout the work, is obvious; and a little attentive consideration will convince the observer of the manner in which the various secondary planes are allied to the primary crystal. Thus in the figure annexed, the planes $\overset{\circ}{f}$ replace the *obtuse* lateral edges of the prism, and incline equally on M and M; the planes $\overset{\circ}{h}$, in like manner, replace the *acute* lateral edges;

the planes *a*, lying between *f* and *P*, replace the *obtuse* solid angles, while *c* 1 and *c* 2, lying between *h* and *P*, replace the *acute* solid angles. The planes *d* 1 to *d* 12 replace the *terminal edges* of the crystal, lying on the *acute* solid angles, in pairs, one of each pair being in the front, and the other on the back of the crystal. The planes *b* 1 and *b* 2 also lie in pairs, but on the *obtuse* solid angles, each pair being in sight, but only one of each is numbered. The planes *i* 1, 2, 3 are in pairs, replacing the *acute* lateral edges, one of each pair only being in sight; while the planes *g* 1, 2, 3 tend to replace the *obtuse* lateral edges, being also in pairs, visible in the figure on each side of the plane *f*.

The *getting-up* of the present edition is a considerable improvement on the second; the paper is much better, the type clearer, and the general appearance of the book neater and more elegant. The size of the work renders it a very convenient travelling companion, and the able manner in which a vast quantity of information is condensed into a small compass, makes it equally serviceable in the cabinet or the carriage.

II. *Traité Élémentaire des Réactifs, leurs Préparations, leurs Emplois spéciaux, et leurs Applications à l'Analyse.* Par MM. A. PAYEN, Manufacturier; et A. CHEVALLIER. Paris, 1822. 8vo. Pp. 224.

IF we except the fourth volume of Thenard's *Traité de Chimie*, there is no comprehensive system of rules delivered by modern writers for accomplishing these two great objects of chemistry—synthesis to effect analysis, and analysis to effect synthesis. Thenard is, however, excellent, in as far as he could be supposed to discuss so extensive a matter in 225 pages of rather open letterpress. He classifies under the six distinct heads of gases, combustible bodies, products of combustion, mineral salts, mineral waters, and vegetable and animal substances, the various subjects of analytical research; conveying judicious precepts for the elimination of the different constituents of a compound, and for ascertaining their proportions. In a short concluding chapter he describes the processes by which we may discover to what class of bodies, and consequently to what chapter of his instructions, any unknown substance is to be consigned. Of the estimation in which M. Thenard's system of analysis is held in this country, no better evidence need be adduced than the fact of two independent translations of it into English having been executed by very able hands. It is equally respected in France.

However valuable it may be, as a summary digest of analytical methods, its limits necessarily preclude many details of great interest and importance. We were, therefore, well pleased to observe the announcement of the work, whose title is prefixed to the present

article. Its authors have been for some time active contributors to the *Journal de Pharmacie*. M. Payen, who is a manufacturer of sal ammoniac, lately wrote a good memoir on the discolouring properties of charcoal, to which the second prize was awarded by the Pharmaceutical Society of Paris. M. Chevallier published some time since an Analysis of the Mineral Waters of Pontivy; and the two gentlemen conjoined, inserted in the *Journal de Pharmacie* for September last, Experiments on the colouring matter of the Petals of the *Malva Silvestris*, and of the wood of St. Lucie (*Cerasus Malaheb*) employed as reagents, in which they sought to appreciate numerically their sensibility to alkalis and acids, compared with other coloured tests.

We were accordingly willing to expect, in a new treatise on chemical tests, published in the French capital, some novelty in the agents, or some ingenuity in their applications; something, in fact, to justify the appearance of such a work soon after the third edition of Thenard. But we are sorry to acknowledge that our expectations have been greatly disappointed.

MM. Payen and Chevallier have not, in reality, indicated any method of re-agency which is not better described in the Professor's treatise; while they seem to be unacquainted with many things which had been long ago effected in the same department by Bergman, whose treatise on the analysis of mineral waters, as far as his plan required, presents more minute and delicate rules of testing than we can find in the recent *Traité*.

The work is inscribed, in terms of merited respect, to M. Vauquelin, under whose superintendence they profess to have made their chemical studies. We wish they had consulted some of his excellent formulæ of analysis, from which they might have gleaned many ingenious tests.

In a short introduction they give a definition and description of the term re-agent, to which they subjoin the plan of the subsequent book. "Re-agents," they say, "are bodies which, placed in contact with others, give rise to new combinations; and which, during their re-action, produce peculiar and characteristic phenomena, which serve to make these bodies be recognised." Many things, however, which it would be difficult to bring under the above definition, are certainly re-agents; such as change of temperature, (or heat,) electricity, and magnetism. We would, therefore, say, that a chemical re-agent or test is a known body or power, which, being applied to an unknown substance, serves to point out, by characteristic phenomena, its nature or constituents.

Their work is divided into nine chapters. In the first they treat of the forms of bodies, of specific gravity, of the influence of bodies foreign to the combination, of the action of light and electricity. The second chapter discusses caloric, its action on different bodies, and the phenomena to which it gives rise. The third treats of the employment of simple combustible bodies non-metallic and me-

tallic, and of the hydrated oxides. The fourth describes the combinations of simple combustibles with the metals. The fifth considers the bodies which result from the combination of acidifiable principles with hydrogen or oxygen; viz., acids. To this chapter an appendix is subjoined, in which the combination of hydrogen with oxygen, and that of hydrogen with azote are discussed. Water and ammonia are here meant. The compounds resulting from the combination of the acids with the salifiable bases (salts), occupy the sixth chapter. The seventh is devoted to animal and vegetable products. In the eighth the manner of preparing and preserving the re-agents described in the preceding chapters is treated of; and the ninth contains some examples of the application of re-agents to analysis.

It is by no means our intention to follow the steps of our authors through their tedious common-places; nor shall we expend criticism on their vicious arrangement. We would rather use their work as the vehicle of communicating some practical remarks on the important subject which they have, without due preparation, taken in hand to discuss.

Analytical chemistry may be simply *qualitative*, or it may be likewise *quantitative*. To apply the former to an untried form of matter is an exercise of invention, and success in it is the prerogative of chemical genius. In this department, a mind guided by the routine of rules will be frequently at fault. To determine proportions is, perhaps, more irksome and laborious; but, for the most part, it requires much less ingenuity. Circumstances may occur, however, where the research of quantities may call forth no little invention. Two of the best examples to this purpose are to be found in Sir H. Davy's work on Nitrous Oxide and M. Gay-Lussac's Memoir on Prussic Acid.

Re-agents, as extemporaneous indicators, belong chiefly to qualitative analysis; but they may, without the use of the balance, by due care, throw considerable light also on quantity. This two-fold application of tests was much considered by Bergman and Kirwan; but it has been almost wholly overlooked by MM. Payen and Chevallier.

To describe a chemical body is merely to detail its relations to other forms of matter, supposed to be previously known. An enumeration of these relations constitutes, therefore, the properties of the body. Hence a re-agent is a known substance, which, possessing some marked relation to another substance, serves, by its action with it, to ascertain its general and specific place in a chemical arrangement. In this extended sense the electroscope, common and voltaic, as well as the magnetic needle, and some optical instruments, deserve to be ranked among tests, though the term is usually restricted to chemical agents.

We conceive that the proper order of discussing the subject of chemical tests would be; first, to describe in succession the various

substances entitled to this distinction, insisting particularly on the *criteria* of their purity; for the chief part of the mis-statements and contradictions to be found in chemical works, has been occasioned by the employment of impure re-agents. The details of their preparation should be referred to the ordinary systems of chemistry. After pointing out the means of verifying the justness of the tests, we should next detail their applications, stating fully the precautions to be observed in their use, and the peculiar phenomena which they produce with their correlative objects.

The second part of the treatise should present in a systematic, and, if possible, in a tabulated form, the various objects of chemical research, simple and compound, with their corresponding tests.

In the third, and concluding division, formulæ illustrated by examples, somewhat in detail, should be given, for evoking in succession the several constituents of a compound by the successive application of their appropriate re-agents.

Mess. Payen and Chevallier have incurred for their treatise the blame of confusion and tautology, by adopting a defective arrangement. In their second chapter we have an account of the action of heat on a long list of substances, placed in alphabetical order; which account would have been better introduced under the description of the various bodies in subsequent chapters. No use, however, is made of the indications of Berzelius. The rambling manner in which our authors sometimes indulge themselves, in trite details, may be judged of from the following specimen:

Tin melts at 228° centig. At a much higher temperature it is reduced into vapour: when elevated to a red heat, if we throw it on the hearth it is divided into incandescent globules, which burn less vividly than those of antimony. It is distinguished, further, from this metal, because it leaves a greyish oxide, heavier than its oxide. Tin is susceptible by the action of heat of being totally oxidized, if we take care to remove the oxide in proportion as it forms on the surface of the metallic bath. By this oxidation the metal augments in weight. Brun, apothecary at Bergerac, is the first who took notice of this phenomenon; not knowing the cause of it, he consulted Jean Rey, physician, who replied, that "the air had become fixed in the metal." This bold reply should have put people in the way of seeing the composition of the atmospheric air. It was long afterwards, however, before its composition was discovered. P. 20.

What they are pleased to say of the blow-pipe is extremely vague, shewing that they were unacquainted with Berzelius's instructions for the use of this admirable test, a subject which they dismiss with a foot-note reference to his *Traité sur le Chalumeau*. They speak indeed of the different intensities of heat in the different parts of the flame, but never hint at the opposite powers of oxidation and reduction which it possesses; the most important discovery ever made in the science of the blow-pipe.—See our *Extracts on this subject* in vol. xiii. p. 325, of *this Journal*; as also *Children's Berzelius*, pp. 29 and 49.

The third chapter is of great length. It treats of simple combustibles and their oxides. We shall take a cursory view of some of its particulars. We find chlorine recommended for demonstrating the presence and proportion of sulphuretted hydrogen, by

the precipitation of sulphur which it occasions in this gas. But the sulphur will not be precipitated in an insulated form, provided enough of chlorine be present. A chloride is the result. Chlorine, when put in contact with carburetted hydrogen, is said to seize the hydrogen, and set the carbon free. But the formation of chloride of carbon renders the above test nugatory.

On turning to their eighth chapter, on the preparation and preservation of re-agents, we find it stated that 200 volumes of chlorine are soluble in 100 of water; and that this solution = 24° on Baumé's hydrometer, corresponding to the specific gravity 1.2. This is a serious error. The above proportions reduced to weight are, 168 chlorine to 1 of water; so that were the total volume of the liquid to remain without increase, its specific gravity would be only 1.006. When the water of chlorine possesses this density or one greater, we may be sure that it is contaminated, probably with muriatic acid. They say that 133 parts of muriate of soda, with 110 of sulphuric acid, and 100 of oxide of manganese, should afford 80 of chlorine. But 133 parts of salt require for decomposition 106 of acid, leaving only four parts of acid, instead of 110, for saturating 100 parts of peroxide of manganese. Instead, therefore, of eighty parts of chlorine, from the above erroneous proportions, little more than forty will be obtained.

When hydrogen is disengaged from dilute sulphuric acid by the agency of zinc, it is properly enough directed to be passed through a solution of potash to deprive it of sulphuretted hydrogen. They take no notice of Berzelius's elegant application of hydrogen gas, as a test of oxygen in bodies; nor of a similar application of chlorine gas in the examination of certain ores.—*See this Journal*, xiii. 156; and xiv. 209.

Their process for procuring iodine is good for nothing; and when they prescribe a solution of this active body in alcohol to be kept as a test, they forget the production of hydriodic acid, which never fails to occur. The solution in alcohol should be, therefore, an extemporaneous prescription. That, or the watery solution, is a very delicate test of the presence of starch in plants, or in their products. A blue or purple colour is produced.

Bright silver is recommended as the test of sulphuretted hydrogen in mineral waters. They justly observe, in describing the process for obtaining the metal pure, that its precipitated chloride should be mixed with caustic potash, instead of the alkaline carbonate, which, during the ignition, is apt to scatter the particles of silver, and prevent them running together into a button at the bottom of the crucible. Tin affords the best criterion of a tungstate. When the metal is plunged into a solution of the salt, a blue precipitate falls, which has not been examined. Messrs. Payen and Chevallier prescribe, after Bergman, for the analysis of cast iron, to measure the bulk of hydrogen evolved during its solution in dilute sulphuric acid. They affirm that one gramme of iron should yield in this way 458 gramme measures of hydrogen, at 32° F. and

29.9 barom. pressure. By our calculation, one gramme of iron should afford only 424 gr. measures of hydrogen.

Pure zinc must be sought for by reducing to the metallic state the oxide thrown down from the purified sulphate. When this metal is employed to separate copper from its saline solutions, we must remember, that it precipitates this metal from the nitrate chiefly in the form of a subnitrate.

In the preparation of lime-water, we are rightly desired to reject the first portions of the solution, which may contain some saline matter. Lime-water is the usual test of corrosive sublimate; but hydriodate of zinc is much better. That water is also the common test of carbonic acid in an alkaline ley. We shall see presently that subacetate of lead is a far more delicate test. The chief employment of magnesia as a re-agent is in vegetable analysis, where it serves conveniently to precipitate the vegetable alkalis from their native combinations in the substance of plants.

Liquid potash is recommended for detecting the artificial coloration of wines. It affords, with these liquids, the following precipitates relative to the different colouring matters employed.

With the natural principle of wine the precipitate is green

Berries of yeble	.	.	.	violet
Indian wood	.	.	.	violet-red
Mulberries	.	.	.	violet
Brazil wood	.	.	.	red
Beet	.	.	.	red
Turnsole or litmus	.	.	.	clear violet
Myrtle berries	.	.	.	wine-lees colour
Elder berries	.	.	.	bluish.

This test may possibly be applied with advantage to detect adulterations in much of the port wine retailed in this kingdom, which is a villanous compound of malt spirit and dye-stuffs.

A separate chapter is allotted to the deuto-chloride and deuto-cyanide of mercury, which bodies might have been better placed among the salts.

The acids used as re-agents are discussed in the fifth chapter. Strong acetic acid dissolves both gluten and resin. Dilution with water throws down the resin, and saturation with an alkali precipitates the gluten.

Arsenious acid is prescribed as a test of sulphuretted hydrogen; orpiment being formed by the combination. An arsenite is distinguishable from an arseniate by nitric acid, which throws down from a solution of the former arsenious acid in powder.

They free iron from cobalt by means of oxalic acid; the oxalate of the latter metal being insoluble.

Sulphite of lime is enjoined as a substance capable of arresting the fermentation of wines, and other vegetable juices.

A bar of zinc is said to answer for distinguishing the ammoniuret of copper from that of nickel. It precipitates the copper in the metallic state, whilst it occasions no change in the solution of pure nickel.

For separating nickel and cobalt, they adopt M. Laugier's process; who dissolves the oxalates of the two metals in water of ammonia. On exposing the solution to the air, the nickel precipitates, while the cobalt remains dissolved. Thus, it is said, a perfect separation can be effected. The details of this process were given some years ago in this Journal; but we have since found them practically exceptionable.

The sixth chapter treats of the principal salts, employed as re-agents. The application of acetate of lead, to estimate sulphuretted hydrogen, is one of the best chemical tests. The sulphates and carbonates should have been previously removed by nitrate of barytes. From the weight of the sulphuret of lead, the quantity of sulphur, amounting to $\frac{2}{15}$, may be computed; to which fraction, if we add $\frac{1}{16}$, the sum will denote the weight of the sulphuretted hydrogen. Another very general use of acetate of lead is, the separation of the acids from vegetable juices, or infusions. On exposing the saturnine salt to a current of sulphuretted hydrogen gas, the lead is converted into a sulphuret, and the vegetable acid remains free. By the same acetate, the tartaric acid is distinguished from the pyro-tartaric, the former yielding a precipitate of tartrate of lead; while the latter acid remains in solution. Acetate of lead is sometimes used as a test of sulphuric acid; but it is not very delicate. It will not detect $\frac{1}{16000}$, a quantity sensible to litmus infusion, or even pale litmus paper. Paper, imbued with acetate of lead, is a convenient test of sulphuretted hydrogen. Sub-acetate of lead is incomparably the nicest re-agent for detecting carbonic acid, or a carbonate, in solution. The same salt serves to separate picromel from the bile. For this purpose, we pour into that animal product, first, acetate of lead in excess. The whole of the yellow matter and the resin, fall down, in union with the oxide of lead. This oxide carries with it also, the phosphoric and sulphuric acids, which exist in the bile, in the state of phosphate and sulphate of soda. The liquor being filtered, and the precipitate washed, we pour into the clear solution sub-acetate of lead. The excess of oxide in this salt combines with the picromel, and is deposited with this substance, in the form of yellowish-white flocks. These being thrown on a filter, and repeatedly washed with water, are to be dissolved in dilute acetic acid, and the solution is to be exposed to a current of sulphuretted hydrogen. The lead falls down in the state of sulphuret. By evaporating the supernatant liquid, pure picromel is obtained.

MM. Payen and Chevallier mention a ready method of

ascertaining the proportion of alcohol in wines, beer, cider, &c., long ago described by Mr. Brande, to 100 parts in volume of the liquid : to be tried, 12 parts of solution of sub-acetate of lead * are to be added ; a precipitation ensues : which is rendered general by slight agitation. On filtering, a colourless fluid, containing the alcohol, is procured. By mixing with this dry carbonate of potash, (calcined pearl-ash,) as long as it is dissolved, we separate the water from the alcohol. The latter is seen floating above in a well-marked stratum ; the quantity of which can be estimated at once, in a measure tube. Sub-acetate of lead is also employed for precipitating mucus in a flocky form, from its mixture with gelatine, which is not affected by the salt.

Borax, in coarse powder, or small lumps, is much employed by the French chemists, for separating muriatic and sulphurous acids from other gaseous bodies.

To detect lime in sugar, muriate of ammonia in powder is mixed with it, and heated. Pungent ammonia exhales. For the separation of alumina from its solution in an alkaline ley, sal ammoniac is the proper re-agent. A muriate of potash is formed ; while the ammonia and alumina are both disengaged.

Under muriate of barytes, nothing is said, of the numerical power of this test of sulphuric acid. According to Kirwan, a solution of this salt produced a very sensible precipitation in water that contained only $\frac{1}{910256}$ of real sulphuric acid. Acetate of lead is ten times less sensible to this acid ; while nitrate of lead, as well as nitrate and muriate of strontian, are far inferior tests. When the acid is combined with a base, as in sulphate of soda, the barytic salt is 11 times less sensible, even after two or three hours of re-action, than with the free acid. According to Bergman, solution of muriate of barytes *immediately* discovers about $\frac{1}{14625}$ of combined sulphuric acid, or $\frac{1}{81233}$ in two or three hours. The same test took twenty-four hours to detect one grain of sulphate of lime in 6000 of water.

Where boracic acid is suspected to be mixed with sulphuric, in a mineral water, muriate of strontian is a convenient re-agent, as it throws down the latter without affecting the former acid. In general, when muriate of barytes is applied to measure the amount of sulphuric acid, we should digest the precipitate in nitric acid of moderate strength ; then wash, dry, and ignite. Thus the phosphate, borate, malate, tartrate, &c., will be removed.

Muriate of potash is prescribed for distinguishing tartaric from citric acid ; for when it is added to a solution of the first, small brilliant crystals of bitartrate of potash fall ; with the last acid, no change ensues.

* This solution is made by boiling 15 parts of pulverized (and calcined) litharge, with 10 of acetate of lead, in 200 of water, for 20 minutes, and concentrating the liquid by slow evaporation to one half ; it must be kept in well-corked phials, quite full.

Proto-muriate of tin converts the molybdic into the molybdous acid; and therefore occasions with it, and molybdate of potash, a characteristic blue precipitate.

Nitrate of silver is capable, according to Bergman, of detecting $\frac{1}{42250}$ of common salt in water; after standing some time, it would discover a much smaller quantity. According to M. Pfaff, proto-nitrate of mercury is a still more sensible test of muriatic acid. One part of muriatic acid, specific gravity 1.15 (equivalent to 0.283 of chlorine) diluted with 70.000 of water, is scarcely rendered feebly opalescent by the nitrate of silver; and when the dilution amounts to 80000, the effect is null. But the sensibility of proto-nitrate of mercury is such that even $\frac{1}{300000}$ of muriatic acid at 1.15, is indicated by a slightly chill shade in the water. MM. Payen and Chevallier maintain the superior delicacy of the silver test.

Proto-nitrate of mercury is said by Pfaff to be the most delicate re-agent for ammonia; one part of this alkali, diluted with 30000 of water, is indicated by a faint blackish-yellow shade, on adding the mercurial solution. Proto-nitrate of mercury may also be used for detecting phosphoric acid; the precipitate being redissoluble in nitric or phosphoric acid, which chloride of mercury is not.

Nitrate of silver serves to distinguish kinic from the other vegetable acids. The salts of the first acid do not disturb the transparency of the nitrates of silver, mercury, or lead. One grain of oxalic acid, according to Bergman, detects one grain of lime in 42250 of water. Oxalate of ammonia is, however, the suitable form of applying this test; MM. Payen and Chevallier say that it is sensible to $\frac{1}{25000}$ of lime.

In the seventh chapter of their treatise, where vegetables and animal re-agents are described, we find the following table of the solubility of some fixed oils in alcohol of specific gravity 0.817, at the temperature of 54°. 5 F.

Oil of sweet almonds	0.003
Beech mast . . .	0.004
Linseed . . .	0.006
Hazel-nuts . . .	0.003
Common nuts . .	0.006
Olives . . .	0.003
Poppies . . .	0.004
Ditto, one year old .	0.008

In applying starch as a test of iodine, if the latter be combined with a base, we must liberate it by the addition of an acid, as the muriatic. After this, $\frac{1}{45000}$ of iodine may be rendered manifest by a violet or purple colour.

Animal charcoal deprives vegetable juices not only of their colour, but also removes the whole lime which they may contain;

a property of great consequence in the purification of beet-root sugar.

To distinguish a very small quantity of essential oil in a distilled water, a few drops of solution of muriate of gold are employed. The metal is reduced by the oil, and falls down in a violet powder.

On coloured tests for acidity and alkalinity, MM. Payen and Chevallier give us less definite information than we had expected. The alcoholic infusion of wild mallow petals, yields by evaporation, a colouring matter, which dissolved in water, is sensibly greened by a water containing $\frac{1}{200000}$ of hydrate of potash, or $\frac{1}{100000}$ of hydrate of soda. Lime water, with 10 additional waters, is the limit of dilution at which the mallow paper can be affected; but with 25 waters, the mallow infusion is still greened. Water boiled on calcined magnesia and then filtered, is capable of affecting the same test.

Litmus paper, according to Bergman, is sensible to $\frac{1}{3521}$ of free sulphuric acid in water; but not to a less proportion. The tincture or litmus is, however, much more sensible. When a drop of water impregnated with carbonic acid is applied to strongly dyed litmus paper, no change ensues, because the alkali of the litmus is adequate to the saturation of the minute quantity of that acid in a drop of the liquid; but the same water when poured into a weak infusion of litmus, reddens it perceptibly. In MM. Payen and Cevalier's paper on the wood of St. Lucie, it is stated that water containing $\frac{1}{8000}$ of sulphuric acid just reddens paper stained violet with an infusion of the fruit of that wood; but the infusion itself is sensible to acid diluted to $\frac{1}{20000}$. Litmus paper is said to be sensible to $\frac{1}{14000}$, and the tincture is a still more delicate test. Paper, stained red with infusion of Brazil wood, is an excellent re-agent for distinguishing several acids from one another.—See the extract of M. Bonsdorff's Memoir in this Journal XIV. 226. Paper stained yellow with turmeric is browned by water containing $\frac{1}{2217}$ of dry carbonate of soda; but it must be some time immersed in the liquid. This test is, however, of little use in determining alkalinity, since Mr. Faraday has shewn that it is liable to be browned by strong acids, as also by the boracic, by the green sulphate and muriate of iron, sub-muriate of zinc, super-nitrate of bismuth, diluted chloride of antimony, of a strong solution of muriate of manganese, muriate, sulphate, acetate, and nitrate of uranium, and muriate of zirconia. See this Journal XIII. 315, XIV. 234. Rhubarb colour has similar fallacies. Mr. South shewed long ago, that subacetate of lead reddens turmeric.

Brazil wood is a pretty delicate test of alkalis; but it is blued by waters containing earthy carbonates, and sulphate of lime. Water holding in solution $\frac{1}{100000}$ of dry carbonate of soda, affects Brazil wood paper. Kirwan says, however, that it is not affected by water impregnated with $\frac{1}{500}$ of selenite. Reddened litmus paper is blued by water which contains $\frac{1}{2438}$ of dry carbonate of soda, according to Bergman. Infusion of red cabbage or of violets,

and paper stained with their colours*, are also good tests, of acid and alkali; but less sensible than the preceding.

The ninth chapter of MM. Payen and Chevallier's work treats of the application of different re-agents to analysis; here we find little worthy of remark. Their instructions are neither so systematic nor so precise as those given by M. Thenard. The method of detecting magnesia, invented by Dr. Wollaston, and published long ago by his lamented friend, Dr. Marcet, in the second edition of *Saunders on Mineral Waters*, is briefly mentioned by our authors. The elegant manner in which the inventor practises this process on the smallest scale, having been somewhat vaguely described by M. Clement, in the *Annals de Chimie et de Physique*, for July, 1822, we shall take the liberty here of detailing it more precisely.

Dissolve in a watch-glass, at a gentle heat, a minute fragment of the mineral suspected to contain magnesia, dolomite for example, in a few drops of dilute muriatic acid; to this solution, add oxalic acid, to render the lime that may be present insoluble; then pour in a few drops of a solution of phosphate of ammonia†. Allow the precipitate to settle for a few seconds, and decant a drop or two of the supernatant clear liquid on a slip of window-glass; on mixing with this liquid two or three drops of a solution of the scentless carbonate of ammonia, an effervescence takes place; draw off to one side with a glass rod, a little of the clear solution, and trace across it, with the pressure of a point of glass or platina, any lines or letters on the glass plane; on exposing this to the gentlest possible heat (as making a little warm water flow over it), white traces will be perceived wherever the point was applied. These consist of the triple phosphate of ammonia and magnesia.

The whole of this beautiful analytical operation, as performed by Dr. Wollaston, occupies less time than we have taken to write the formula. In the application of this process on the larger scale, the carbonate of ammonia should be added first, which prevents the chance of any simple phosphate of the earth being formed. To estimate the quantity of magnesia present in any compound, we must consider, according to Dr. Marcet, every 100 grains of the triple salt dried at the temperature of 100°F. to be equivalent to 19 of earthy base. If we calcine the salt at a red heat, so as to expel all the water and ammonia, an earthy phosphate remains, which, according to Dr. Murray, contains 40 *per cent.* of magnesia. The theoretic proportions of the bi-phosphate of magnesia are 70 acid + 25 base, or 73.68 + 26.32 in 100 parts, and of the neutral phosphate 35 acid + 25 base, or 58½ + 41½ in 100 parts.

Nitrate of mercury has been lately prescribed as a test for examining sophisticated olive oil; it is prepared by dissolving in the cold 6 parts of mercury in 7½ parts of nitric acid, specific

* The blue petals of the iris or water-flag, afford a good test colour either by infusion or by rubbing them on paper. Radish colour is transferred in the latter way, and forms a pretty delicate test paper.

† Phosphate of soda may likewise be used.

gravity 1.36. This solution when added to oil of grains (as poppy seed oil) leaves it liquid, while it solidifies oil of olives.

We have occasionally adverted in our Journal to the defective and confused notions entertained among the continental chemists about the atomic theory, which, in every useful point of view, is the offspring and growth of this island. The following paragraph, translated from this treatise on re-agents, affords a curious confirmation of our opinion.

Dr. Wollaston, in the construction of the scale of equivalents, did not believe that he could make the numbers tally with the atomic theory; according to which, Mr. Dalton conceives that in the relative weights of the chemical equivalents, we estimate the united weights of a determinate number of atoms. Dr. Wollaston, moreover, did not see the utility of doing so for an instrument of application to practical purposes. However, we have learned, that since the publication of these synoptic rules, Dr. Wollaston has discovered that the doctrine of simple multiples (on which is founded the atomic theory), could be applied to the construction of his logarithmic scale, by simplifying all its relations; for if we assumed for unity, hydrogen instead of oxygen, all the results obtained till the present day would appear to confirm the first data; but, undoubtedly, they have not appeared sufficiently numerous to Dr. Wollaston, to induce him to generalize them. We expect, impatiently, the result of the important labour which this learned chemist has undertaken on this subject.—*Traité* p. 205.

Surely any man acquainted with the first elements of chemistry, who glances his eye over the scale, must see that the successive numbers, corresponding to the names, express the atomic weights or combining ratios of the different bodies, beginning with oxygen at the number 10. The French chemists, in general, have suffered themselves to be mystified on the principles of equivalent and multiple combination by the *Essay of Berzelius, on the Theory of Chemical Proportions*; a work which has done as much injury to the philosophy of the subject, as his precision in analytical research has improved its details. We recommend MM. Payen and Chevallier to read with attention the translation of Dr. Wollaston's Memoir on Chemical Equivalents, inserted by M. Descotils in the *Journal des Mines*, xxxvii. 101.

III. *Reliquiæ Diluvianæ; or, Observations on the Organic Remains contained in Caves, Fissures, and Diluvial Gravel; and on other geological Phenomena attesting the Action of an Universal Deluge.* By the Rev. WILLIAM BUCKLAND, B.D., F.R.S., &c.

THERE are few persons in whom zeal for the progress of a particular branch of natural knowledge is united to the same extent with capacity for the pursuit, as in Professor Buckland; he has taken up a very interesting branch of geology, and has investigated it with no less activity than success, and his researches have conducted him, by the legitimate steps of inductive reasoning, to some very important facts connected with the remote history of the earth. The existence of the bones of a great variety of animals, in some cases of extinct genera, and almost always of ex-

inct species, in the superficial clay and gravel of valleys, and in certain caverns, has long excited the attention of geologists, but they have never been so perspicuously and popularly described as in the work before us; nor have the phenomena which attend their deposition, been so plausibly and philosophically accounted for by any antecedent writer. The fact is, that Mr. Buckland has in almost all cases judged for himself; he has personally visited the spots he describes, perambulated the caverns, exhumated their fossil remains, and inspected their various analogies and associations; instead of viewing the subject through the spectacles of books, and framing hypotheses by the fire-side, we find him busily journeying over a great part of Europe, for the express purpose of collecting information upon the subjects before us, and his success has been adequate to the labour bestowed upon the inquiry; for he has, in our opinion, not merely described, with much accuracy and minuteness of detail, the various districts which he has visited, a task in itself of no small importance and interest; but he has established several important facts in relation to geological theory, upon sound, firm, and indisputable evidence. Such are the leading features and prominent merits of Mr. Buckland's book; but it has other claims, which, in the capacity of reviewers, we think it right to notice, though they are of secondary and inferior consideration: we allude to the variety of collateral information scattered through its pages, connected with the habits of the animals, and to the relief which is given to the dry details by interspersed anecdotes and appropriate quotations; all this renders a work which, in the hands of a German professor, for instance, would have proved insufferably dull and monotonous, not merely very readable, but very interesting and entertaining, without in the smallest degree detracting from its scientific value or literary merit.

It would seem, from the table of contents, that Mr. Buckland's work is intended to be divided into two parts, the first containing an account of the localities and contents of various caves in England and Germany, with some observations on the osseous breccia of Gibraltar, Nice, Dalmatia, &c.; and the second embracing "the evidences of an inundation, afforded by phenomena on the earth's surface." In respect to the manner in which the work is got up, we need only say, that it is published by Mr. Murray.

The cave of Kirkdale, in Yorkshire, forms, as it ought, a leading subject of the volume: the rock which it perforates is that kind of calcareous freestone which constitutes the *oolite* formation, and which, from the circumstance of the ingulphment of several rivers that traverse the district, is probably abundant in caverns. It was discovered in the summer of 1821, by the quarrymen of the neighbourhood, who accidentally intersected its mouth, which was overgrown with bushes, and closed with rubbish, probably the debris of the softer portions of the circumjacent strata. But this original opening has been cut away, and its present entrance is a hole in the perpendicular face of the quarry,

which expands and contracts irregularly, from two to seven feet in breadth, and from two to fourteen in height; the roof and floor are composed of regular horizontal strata of limestone, but in the interior the former is studded with stalactite, and the floor covered with a loamy sediment, of the average depth of about one foot, and concealing the actual floor of the cavern; the surface of this sediment was generally smooth and level.

Above this mud, on advancing some way into the cave, the roof and sides were found to be partially studded and cased over with a coating of stalactite, which was most abundant in those parts where the transverse fissures occur, but in small quantity where the rock is compact and devoid of fissures. Thus far it resembled the stalactite of ordinary caverns; but, on tracing it downwards to the surface of the mud, it was there found to turn off at right angles from the sides of the cave, and form above the mud a plate, or crust, shooting across like ice on the surface of water, or cream on a pan of milk. The thickness and quantity of this crust varied with that found on the roof and sides, being most abundant, and covering the mud entirely where there was much stalactite on the sides, and more scanty in those places where the roof or sides presented but little: in many parts it was totally wanting, both on the roof and surface of the mud and of the subjacent floor. Great portion of this crust had been destroyed in digging up the mud, to extract the bones, before my arrival; it still remained, however, projecting partially in some few places along the sides; and in one or two, where it was very thick, it formed, when I visited the cave a continuous bridge over the mud entirely across from one side to the other. In the outer portion of the cave, there was originally a mass of this kind, which had been accumulated so high as to obstruct the passage, so that a man could not enter till it had been dug away.

It deserves particular remark, that the mud and stalactite never alternate, but that there is simply a partial deposit of the latter on the floor beneath it, in which, and in the lower part of the earthy sediment, the animal remains were chiefly found. In the whole extent of the cave, very few large bones have been discovered that are tolerably perfect; most of them are fragmented, and some into very small pieces, cemented by stalagmite, so as to form an osseous breccia.

In some few places, where the mud was shallow, and the heaps of teeth and bones considerable, parts of the latter were elevated some inches above the surface of the mud and its stalagmitic crust; and the upper ends of the bones thus projecting, like the legs of pigeons through a pie-crust, into the void space above, have become thinly covered with stalagmitic drippings, whilst their lower extremities have no such incrustation, and have simply the mud adhering to them in which they had been imbedded; an horizontal crust of stalagmite, about an inch thick, crosses the middle of these bones, and retains them firmly in the position they occupied at the bottom of the cave.

The bones already discovered in the Kirkdale cave are referable to about twenty-three species of animals, namely, hyæna, tiger, bear, wolf, fox, weasel; elephant, rhinoceros, hippopotamus, horse; ox, and three species of deer; hare, rabbit, water rat, and mouse; raven, pigeon, lark, a small duck, and an unknown bird, about the size of a thrush. These were strewed all over the cave, like a dog-kennel, those of the larger animals, mingled with the rest, even in the inmost and smallest recesses; many of them gnawed, and the number of teeth and solid bones of the tarsus and carpus more than twenty times as great as could have

been supplied by the individuals whose other bones are mixed with them. From the comminuted and apparently gnawed condition of the bones, Mr. Buckland remarks, that this cave was probably, during a long succession of years, inhabited as a den by hyænas, and that they dragged into its recesses the other animal bodies whose remains are found mixed with their own, a conjecture much strengthened by the discovery of the solid calcareous excrement of an animal that had fed on bones, which the keeper of Exeter 'Change at once recognised as resembling the recent *fæces* of the Cape hyæna. Mr. Buckland proceeds to verify this evidence, already very conclusive, by an inquiry into the habits of modern hyænas, of which three species only are known, and all smaller than the fossil one; they inhabit hot climates exclusively, and prowl about at night, clearing away the carcasses and skeletons left by vultures, in preference to attacking living creatures. They are so greedy of putrid flesh and bones, that they follow armies, and dig up bodies from the grave. They inhabit holes and chasms, are strong, fierce and voracious, and their eyes, like those of the rat and mouse, are adapted for nocturnal vision. To such animals the Kirkdale cave would certainly afford a convenient habitation, and the circumstances we find developed in it are consistent with these habits.

We must infer from the circumstance of the bones of the hyæna being as much broken up as those of the animals that formed their prey, that the carcasses of the hyænas themselves were eaten up by the survivors; and it is stated by Mr. Brown in his *Journey to Darfu*, that when a hyæna is wounded, his companions instantly tear him to pieces and devour him. But modern hyænas not only devour their own species, but upon a pinch they actually eat up parts of themselves. An old hyæna in the *Jardin du Roi* at Paris nibbled off his own hind feet, and the keeper of Mr. Wombwell's collection told Mr. Buckland that he had an hyæna some years ago which ate off his own fore paws. We, therefore, can want no further proof of the *voracity* of these animals. We insert the following passages as showing the minuteness and accuracy of Mr. Buckland's talent for investigation of this sort, and as bearing upon some important collateral parts of his inquiry.

I have already stated, that the greatest number of teeth (those of the hyæna excepted) belong to the ruminating animals; from which it is to be inferred, that they formed the ordinary prey of the hyænas. I have, also, to add, that very few of the teeth of these animals bear marks of age; they seem to have perished by a violent death in the vigour of life. With respect to the horns of deer, that appear to have fallen off by necrosis, it is probable that the hyænas found them thus shed, and dragged them home for the purpose of gnawing them in their den; and, to animals so fond of bones, the spongy interior of horns of this kind would not be unacceptable. I found a fragment of stag's horn in so small a recess of the cave, that it never could have been introduced, unless singly, and after separation from the head: and near it was the molar tooth of an elephant. I have seen no remains of the horns of oxen, and perhaps there are none; for the bony portion of their interior, being of a porous spongy nature, would probably have been eaten by the hyænas,—whilst the outer case, being of a similar composition to hair and hoofs, would not long have escaped total decomposition.

The occurrence of birds' bones may be explained by the probability of the hyænas finding the birds dead, and taking them home, as usual, to eat in their den : and the fact, that four of the only six bones of birds I have seen from Kirkdale are those of the ulna, may have arisen from the position of the quill-feathers on it, and the small quantity of fleshy matter that exists on the outer extremity of the wings of birds,—the former affording an obstacle, and the latter no temptation, to the hyænas to devour them.

With respect to the bear and tiger, the remains of which are extremely rare, and of which the teeth that have been found indicate a magnitude equal to the great *ursus spelæus* of the caves of Germany, and of the largest Bengal tiger, it is more probable that the hyænas found their dead carcasses, and dragged them to the den, than that they were ever joint tenants of the same cavern. It is, however, obvious that they were all at the same time inhabitants of antediluvian Yorkshire.

As ruminating animals form the ordinary food of beasts of prey, it is not surprising they should abound in the Kirkdale Cave ; but it is not so obvious by what means the bones and teeth of the elephant, rhinoceros, and hippopotamus were conveyed thither. Mr. B. suggests that these may perhaps be the remains of individuals that died a natural death ; for though a hyæna would neither have had strength to kill a living elephant or rhinoceros, or to drag home the entire carcass of a dead one, yet he could carry away piecemeal, or acting conjointly with others, fragments of the most bulky animals that died in the course of nature, and thus introduce them to the inmost recesses of his den.

Should it be asked, why no entire skeleton has been found, we find a reply in the habit of the hyæna to devour the bones of his prey, and the gnawed fragments and *album græcum* afford evidence of such propensity having been gratified, though the latter is in much less quantity than we should have expected to find it ; but from its want of aggregation when recent it would probably have been soon disintegrated and trodden down, except in particular instances of extreme constipation. The question which naturally suggests itself, why we do not find at least the entire skeleton of the one or more hyænas that died last, and left no survivors to devour them, is, we think, satisfactorily answered by our author, who ingeniously observes that the last individuals were probably destroyed by the diluvian waters, on the rise of which they may be supposed to have rushed out of their dens and fled for safety to the hills—that they were extirpated by this catastrophe is shown by the discovery of their bones in the diluvial gravel both of England and Germany.

Having thus summed up our author's evidence in favour of the Kirkdale Cave having been inhabited as a den by successive generations of hyænas, we shall not stop to consider the other hypotheses which may be suggested in reference to it ; but proceed to some considerations which it suggests. In the first place, it appears manifest, that the accumulation of bones must have gone on through a long succession of years, *while the animals in question were natives of this country*. Secondly, the general dispersion of similar bones through the gravel of great part of the northern hemisphere, shows that the period in which they inhabited these regions immediately preceded the formation of this gravel, and that

they perished by the same waters which produced it. Thirdly, that the bones belonged to extinct species which have never re-established themselves in the northern portions of the world. The phenomena of this cave, therefore, seem referable to a period immediately antecedent to the last inundation of the earth, when it was inhabited by land animals bearing a generic and often a specific resemblance to those which now exist; and they also seem to demonstrate that there was a long succession of years in which the elephant, rhinoceros, and hippopotamus had been the prey of the hyænas, which, like themselves, inhabited this country in a period immediately preceding the formation of the diluvial gravel. The catastrophe producing this gravel appears to have been the last event that has operated generally to modify the surface of the earth, and the few local and partial changes that have succeeded it, such as the formation of torrent gravel, terraces, peat bog, &c. all conspire to show that the period of their commencement was subsequent to that at which the diluvium was formed.

But we come now to one of the most curious parts of the very curious subject before us, which is, that four of the genera of animals whose bones are so widely dispersed over the temperate and polar regions of the northern hemisphere, at present exist in tropical climates only, and chiefly indeed south of the equator; and that the only country in which the elephant, rhinoceros, hippopotamus, and hyæna are now associated is southern Africa. In the neighbourhood of the Cape of Good Hope, they all live and die together, as they probably formerly did in Britain, whilst the hippopotamus is now confined exclusively to Africa, and the elephant, rhinoceros, and hyæna are also diffused widely over the continent of Asia.

As we consider it amply proved, by Mr. Buckland's researches, that the animals actually lived and died where their remains are now found, and were not drifted thither by diluvian torrents, it is pretty obvious either that the antediluvian climate of these latitudes was warmer, or that the animals had a constitution adapted to the regions of a northern winter. This last opinion derives support from the Siberian elephant's carcass discovered entire in the ice of Tungusia, the skin of which was covered by remarkably long hair and wool; and, in 1771, an equally remarkably hairy rhinoceros was found in the same country. There are, moreover, existing animals which have species adapted to the extremes both of polar and tropical climates. Though we confess ourselves rather inclined to adopt this view of the subject, it must be confessed that many stubborn facts may be urged against it, a few of which have been well put by Mr. Buckland, who espouses the former opinion. Such, for instance, as the abundance of vegetable remains, as well as those of animals, which are now peculiar to hot climates, but which abound in the secondary strata and diluvium of high northern latitudes. "To this argument," continues our author:—

To this argument I would add a still greater objection, arising from the difficulty of maintaining such animals as those we are considering amid the rigours of a polar winter; and this difficulty cannot be solved by supposing them to have migrated periodically, like the musk ox and rein-deer of Melville Island; for, in the case of crocodiles and tortoises, extensive emigration is almost impossible, and not less so to such an unwieldy animal as the hippopotamus when out of water. It is equally difficult to imagine that they could have passed their winters in lakes or rivers frozen up with ice; and though the elephant and rhinoceros, if clothed in wool, may have fed themselves on branches of trees and brushwood during the extreme severities of winter, still I see not how even these were to be obtained in the frozen regions of Siberia, which at present produce little more than moss and lichens, which, during great part of the year, are buried under impenetrable ice and snow; yet it is in those regions of extreme cold, on the utmost verge of the now habitable world, that the bones of elephants are found occasionally, crowded in heaps, along the shores of the icy sea from Archangel to Behring's Straits, forming whole islands composed of bones and mud at the mouth of the Lena, and encased in icebergs, from which they are melted out by the solar heat of their short summer, along the coast of Tungusia, in sufficient numbers to form an important article of commerce.

The chronological inferences deducible from the furniture of the Kirkdale den are summed up by Mr. Buckland at the conclusion of his description of it, and are briefly as follows: 1. There appears from the state of the sides and bottom of the cave, (beneath the bony aggregate,) to have been a period in which it existed as an untenanted and empty aperture. 2. It was inhabited by hyæna's, &c.; and, as we might suppose, stalactitic and stalagmitic formation still went on in it. 3. Mud was introduced, and the animal at the same time extirpated. 4. Stalagmite was again deposited, as shown by the crust upon the surface of the mud, and during this period no creature seems to have entered the cave, save and except rats, mice, rabbits, and foxes. From the limited quantity of the latter stalactite, and from the undecayed condition of the bones, our author argues that the time elapsed since the deluge is not of excessive length, that is, not exceeding six thousand years.

With the mass of minute and accurate information, derived from his visits to the cave at Kirkdale, Mr. Buckland proceeds to inspect several similar accumulations of bones in other parts of England; and having satisfied himself of their general concordance with the above, and of the verification which they afford of his main deductions, he determined upon a visit to some celebrated similar depositaries in Germany, of which the volume before us contains the most entertaining and instructive account extant. He shows from the history and contents of the diluvian gravel of the Continent, that it is identical with that of our own island; and that with respect to the bones that occur in caverns, the chief difference seems to be, that in Germany some of the caves have remained open, and have consequently been inhabited by modern or existing species. We cannot follow our indefatigable author into the details and descriptions of the interiors and contents of all these diluvian cemeteries, but the following remarks apply generally to them all:—

With respect to the apertures themselves, whether fissures or caverns, they appear to have been without mud or pebbles when the animals lived and died, whose remains are now found in them. In regard to the present mouths of these dens, our author adduces evidence to show, that they did not exist formerly as at present, but that they are rather truncated portions of the lower regions of the original caverns, laid open as it would seem by the diluvial waters which excavated the valleys in whose cliffs they stand, and which also drifted into these the mud and pebbles. The diluvial matter itself Mr. Buckland describes as either a mass of pebbles, or of loam, or sand, with bones indiscriminately distributed through them, and sometimes cemented into an osseous breccia by stalagmitic infiltrations; in short, there is a complete analogy between the caves of Germany and of England, not merely in respect to their earthy and osseous deposits, but in the species of the animals whose remains are enveloped in them.

The osseous breccia of Gibraltar, Nice, Dalmatia, &c., comes next under our author's observation, and is ascribed to the same antediluvian period, with the exception of certain more recent deposits, of which some of our English caves and fissures also furnish instances, and which are ascribed to animals that have more lately fallen into them: when, however, the mouths of the fissures are closed, no such recent reliquiae occur, and all is of a more ancient date.

The subject of human fossil remains is one of peculiar interest to the geologist, and particularly so in relation to the destruction of the human race by the deluge. But no human remains have yet been found associated with any of the unequivocal antediluvian inhabitants of the earth. Human bones, and even urns have been discovered in the caves of Gailenreuth and Zahnloch. In England, too, many human skeletons have been found in caverns, but always attended by circumstances which announce them of postdiluvian origin. Our author examined the remains of human bodies in the cave of Wokey Hole near Wells, and the following are his remarks upon them:

They have been broken by repeated digging to small pieces; but the presence of numerous teeth establishes the fact that they are human. These teeth and fragments are dispersed through reddish mud and clay, and some of them united with it by stalagmite into a firm osseous breccia. Among the loose bones I found a small piece of a coarse sepulchral urn. The spot on which they lie is within reach of the highest floods of the adjacent river; and the mud in which they are buried is evidently fluvial, and not diluvian; so also is great part, if not the whole, of the mud and sand in the adjacent large caverns, the bottoms of all which are filled with water to the height of many feet, by occasional land-floods, which must long ago have undermined and removed any diluvial deposits that may have originally been left in them. I could find no pebbles, nor traces of any other than the human bones, on the single spot I have just described; these are very old, but not antediluvian. In another cave on this same flank of the Mendips, at Compton Bishop, near Axbridge, Mr. Peter Fry, of Axbridge, discovered, in the year 1820, a number of bones of foxes, all lying together in the same spot, and brought away fifteen skulls. These, also, like the remains of foxes in Duncombe Park and near Paviland, are of postdiluvian origin, and were probably derived

from animals that retired to die there, as the antediluvian bears did in the caves of Germany.

In the neighbourhood of Swansea a number of human bones have also been found in a fissure of the limestone-rock; these are apparently the remains of bodies thrown in after a battle, and are not associated with any more ancient bones, or any appearances which connect them with antediluvian relics.

These and other instances of the existence of human bones, lead us to refer them to periods subsequent to those of the unequivocal diluvial deposits; indeed, the great abundance of the remains of wild animals in the latter lead us to believe that the countries could not have been inhabited by man; but that, on the contrary, the beasts must then have enjoyed sole dominion. Upon this subject our author agrees in opinion with Mr. Weaver.

That the satisfactory solution of the general problem, as far as it relates to man, is probably to be sought more particularly in the Asiatic regions, the cradle of the human race; and that another interesting branch of inquiry connected with it is, whether any fossil remains of elephant, rhinoceros, hippopotamus, and hyæna, exist in the diluvium of tropical climates; and if they do, whether they agree with the recent species of these genera, or with those extinct species, whose remains are dispersed so largely over the temperate and frigid zones of the northern hemisphere.

Having thus illustrated his account of Kirkdale, and of the caves in England, by a comparative view of similar caverns and fissures on the Continent, our author proceeds in the second part of his book, to consider the evidence of diluvial action afforded by the accumulation on the earth's surface of loam and gravel, containing the remains of the same species of animals that we find in the caves and fissures, and by the form and structure of hills and valleys in all parts of the world. Of these remains, the bones of the fossil elephant are the most remarkable from their general and abundant dispersion; it differs from all living species of that genus, but approaches more closely to the Asiatic than to that of Africa; and, if we may judge from the Siberian specimen already adverted to, it was clothed with a coarse reddish wool, interspersed with stiff black hair, forming a long mane on its neck and back, and was at least 16 feet high.

It was to be expected that the remains of this gigantic animal should be found in the diluvial gravel of Yorkshire, from the fact already established, that these animals inhabited the neighbourhood of Kirkdale, whilst its caverns were occupied by the hyæna; and accordingly tusks and bones of elephants of enormous size have been found in the diluvium at Robin Hood's Bay, near Whitby; at Scarborough, Bridlington, and several other places along the shore of Holderness. Proceeding southwards we also find them in the interior of Suffolk, Norfolk, and Essex; and at Walton, near Harwich they are extremely abundant, blended with other diluvial bones. In the valley of the Thames they have been discovered at Sheppy, the Isle of Dogs, Lewisham, London, Brentford, Kew, Wallingford, Dorchester, Abingdon, and Oxford. On the south

coast of England they occur at Lyme and Charmouth, and they have been found in the central counties. In North Wales, Scotland, and Ireland, these relics have also been met with always in the superficial gravel or loam, and never imbedded in what may be called the regular strata.

The circumstances that attend some of these deposits require to be more particularly detailed. In the streets of London, the teeth and bones are often found, in digging foundations and sewers, in the gravel *e. g.*, elephants' teeth have been found under twelve feet of gravel in Gray's-Inn Lane; and lately, at thirty feet deep, in digging the grand sewer, near Charles Street, on the east of Waterloo Place. At Kingsland, near Hoxton, in 1806, an entire elephant's skull was discovered, containing two tusks of enormous length, as well as the grinding-teeth: they have, also, been frequently found at Ilford, on the road from London to Harwich; and, indeed, in almost all the gravel-pits round London. The teeth are of all sizes, from the milk-teeth to those of the largest and most perfect growth; and some of them show all the intermediate and peculiar stages of change to which the teeth of modern elephants are subject. In the gravel-pits at Oxford and Abingdon, teeth and tusks, and various bones of the elephant, are found mixed with the bones of rhinoceros, horse, ox, hog, and several species of deer, often crowded together in the same pit, and seldom rolled or rubbed at the edges, although they have not been found united in entire skeletons.

For foreign localities of the fossil elephant our author refers to Cuvier's account of places in which they have been found all over Europe. Of these one of the most remarkable is in the valley of the Arno, near Florence, where they occur associated with parts of the skeletons of hippopotami rhinoceri, hyænas, bears, tigers, wolves, &c. In Asiatic Russia, from the Don to the extremity of the promontory of Tchutchis, there is not a river, in the banks of which they do not find elephants and other animals now strangers to that climate.

In treating of the evidence of the diluvial action afforded by deposits of loam and gravel, Professor Buckland very justly remarks, that the theories suggested to account for such appearances, have been defective from their attempting to refer to one circumstance two distinct classes of phenomena; namely, the general dispersion of gravel and loam over hills and elevated plains as well as valleys; and the partial collection of gravel at the foot of torrents, and of mud along the course and at the mouths of rivers. The former of these only appears to be the effect of an universal and transient deluge, whilst the latter are distinctly referable to the action of existing causes.

I have seen a good example of these two deposits in Holland in immediate contact with one another. The alluvial detritus of modern rivers, which is so enormous in that country, never rises above the level of the highest possible land-floods; but beneath this level forms nearly the entire surface of that low and extensive flat; whilst the diluvial deposits rise from beneath it into a chain of hills, composed of gravel, sand, and loam, which cross Guelderland, between the Yssel and the Rhine, from the south-east border of the Zuyder Zee, to Arnheim, and Nymegen, and form at the latter place a cliff, overhanging the left bank of the Waal, and another cliff of the same kind on the right bank of the Rhine, from Arnheim to Amerongen, on the road to Utrecht. In the districts that lie below the flood-level of these rivers, it is probable that there is an extensive deposit of this same diluvium buried beneath the alluvium, which forms the sur-

face; and the certainty of this fact has been established in several places, where, from the bursting of dykes, the water has made excavations through the alluvium into the subjacent diluvium, and washed up from it the teeth and bones of the extinct elephant and other animals, which are peculiar to that formation.

We are sorry that we have neither space nor time for more extended quotations from this part of the work before us, which, though less captivating to the general reader than the history of the dens and their inhabitants, is, in a geological point of view, replete with important and essential data; and as we discover among the pebbles that constitute this diluvial gravel not merely the wreck of the adjacent inland districts, but also large blocks of primitive and transition rocks which do not occur in England, and which can only be accounted for by supposing them to have been drifted from the nearest continental strata of Norway, we must admit that a diluvial current from the north is the only adequate cause that can be proposed, and that satisfies the conditions of the problem.

In reference to this subject Mr. Buckland has given a summary of facts selected from various authorities, and from his own extensive observations, which tend satisfactorily to explain the great transportation of materials from one district to another at the period of the deluge, and which also elucidate the excavation of valleys, and develope the general causes of those minor irregularities which are engraved upon the earth's surface. The general shape of hills and valleys; the immense deposits of gravel and boulders, evidently immovable by any streams now existing; the nature of these rounded fragments; the condition of the organic remains that accompany them, and the analogous occurrence of similar phenomena in all regions of the world hitherto investigated, are such decided and convincing proofs of the universality of the diluvial inundation, as must, independent of any other evidence, overrule all objections and difficulties connected with this very important subject. That there are difficulties to be removed, discordances to be cleared up, and doubts to be obviated, Mr. Buckland does not pretend to deny; but it is probable that these will, at length, be removed by the extension of observations, physical and geological, conducted upon the plan so ably laid down and successfully pursued in the work before us.

In conclusion, we shall only remind our author of the excellent advice and instructive observations of the President of the Royal Society, on presenting him with the Copley medal for his original description of the cave at Kirkdale, printed in the *Philosophical Transactions* for the year 1822. On that occasion Sir H. Davy took a luminous view of the importance and bearings of such researches, and suggested, in terms at once explicit and eloquent, the line of inquiry most likely to promote and perfect them; and the honours, thus conferred by the Royal Society, seem not to have been scattered upon barren ground, for to them we apparently owe

the extended and minute description of the caves in Germany, contained in the present volume and the undiminished zeal with which Mr. Buckland is, as we are informed, at present pursuing his geological investigations.

To the Editor of the Journal of Science, &c.

SIR,

The candour and liberality by which your excellent Journal is so honourably distinguished, lead me to hope that you will admit a few observations, intended to remove an impression to the disadvantage of a highly respectable character.

In the review of "A Comparative Estimate of the Mineral and Mosaical Geologies," by Granville Penn, Esq., No. 29, page 112, is the following passage: "De Luc would not use the term *created*, 'because,' said he, 'in physics I ought not to employ expressions which are not thoroughly understood between men.'" Our author reprobates his conduct and his argument with just severity: "Was he aware," says Mr. Penn, "that in excluding the word, he at the same time excluded the idea associated with the word, and together with the idea, the principle involved in that idea; the exclusion of which is the very parent cause of all materialism and all atheism." The reader of this paragraph, if unacquainted with the writings and the character of Mr. De Luc, will certainly suppose that he did not believe, or at least thought it unphilosophical to acknowledge, that "in the beginning God created the heavens and the earth;" and the memory of one of the best and most pious of men may be injured by those who are ably defending the same cause which it was the business of his life, and the object of all his writings, to advocate. In the introductory chapter to "*L'Histoire de la Terre et de l'Homme*," Vol. 1, page 22, he says: "Je declare des l'entrée, que la consequence immediate de toute la partie physique de cet ouvrage est, que la Genèse, le premier de nos livres sacrés, renferme la vrai histoire du monde; c'est a dire, que l'étude de la terre nous en montre les plus grands traits, et n'en contredit aucun."

Page 50. "Je suis convaincu de la certitude de la revelation et j'apporte ma petite contribution dans ses moyens de défense."—"J'entrepris d'observer le monde moral et physique; je lus ce qu'en disoient les philosophes, et bientôt je soupçonnai que ceux qui abandonnoient Moïse voyoient mal on raisonneient sans examen."

After having, with the assistance of his brother, devoted thirty years to actual observation of the present state of the earth, Mr. De Luc says: "Lorsque nous fumes persuadés, par l'étude des phénomènes, que le recit de Moïse sur l'histoire de notre globe étoit le seul système vrai, nous formames le dessein d'en instruire ceux qui ne recherchent pas."—Vol. 5. page 759.

The whole intention of De Luc's writings, during the course of a long life, is to confirm the Mosaic account of the creation and the deluge by accurate investigation of the present state of the globe. His system, with regard to the Deluge, is the same as that of Mr. Penn in his "Comparative Estimate, &c.;" and I believe that very able work would have met with his warm approbation. The only circumstance in which De Luc may appear to depart from the literal sense of the first chapter of Genesis, is with regard to the length of the period there called a day. Whether he was right or wrong in his ideas on that subject I do not presume to decide, but he certainly had no intention to deviate from the *meaning* of Moses, for every part of his work is written to support the authority of Scripture. Those who will take the trouble to look into his fifth volume, page 630, will find a clear account of his sentiments, which I should injure by attempting to curtail it. I could prove what I have here asserted from almost every page of his numerous publications, and particularly from his Letters to M. Le Tellier; but I will only beg leave to call your attention to the passage which you say Mr. Penn "reprobates with just severity." According to this gentleman's translation, De Luc says: "I shall not say *created*, because in physics I ought not to employ expressions which are not thoroughly understood between men." The original is given in a note, and the words are, "Je

ne dirai pas qu'elles ont été créées ainsi, parce-qu'en physique je ne dois pas employer des expressions sur lesquelles *on ne s'entend pas*."—Tom. 2. page 211. I request any person acquainted with the French language to compare the original with the translation, and they will see that the author has been misunderstood, and that his meaning is as follows: "I will not say that they have been created *thus*," (in their present state,) "because in physics I must not employ expressions on the sense of which people *are not agreed*." The whole passage runs thus. After describing two classes of mountains, he says of the second, "On les a nommées secondaires, et les autres primitives. J'adopterai la première de ces expressions, car c'est la même qui nous étoit venue à l'esprit, a mon frère et à moi, longtems avant que nous l'eussions vue employer; mais je substituerai celle de primordiales, à primitive, pour l'autre classe de montagnes, afin de ne rien décider sur leur origine. Il est des montagnes dont jusqu'à présent on n'a pu démêler la cause; voilà le fait. Je ne dirai donc pas qu'elle ont été créées ainsi, parce qu'en physique je ne dois pas employer des expressions sur lesquelles on ne s'entend pas. Sans doute cependant, que l'histoire naturelle, ni la physique, ne nous conduisent nullement à croire que notre globe ait existé de toute éternité, et lorsqu'il prit naissance il fallut bien que la matière qui la composa fut de quelque nature, on sous quelque première forme integrante. Rien donc n'empêche d'admettre que ces montagnes, que je nommerai primordiales ne soient réellement primitives; je penche même pour cette opinion."—Without pretending to any skill in geology, I appeal to the common sense of any person who can read and understand this quotation; and I ask whether the writer can be suspected of wishing to exclude the idea of creation?

If I express myself with warmth on this subject, I beg that I may not be supposed to speak with disrespect of Mr. Penn's admirable work, or to suspect the excellent author of intentional misrepresentation of a fellow-labourer in the same cause; but the character of a friend, whom I have respected and esteemed for more than forty years, is sacred in my eyes. Mr. De Luc was one of the best men and best christians that I have ever known, and I knew him *well*. Our late excellent king and queen honoured him with their esteem and confidence. Her majesty was his pupil during many years, and she would not have received instruction from a person whom she did not believe to be a *safe* guide on the important subjects of his lectures. He was sent by the king to Germany, to inquire into the state of religion there, and particularly into the views of the Illuminati, whose dangerous principles were first developed by him. It was De Luc who ventured to caution his royal master against the plausible, but dangerous, system of education, which it has since been found expedient to counteract, by establishing the national schools. On every occasion, M. De Luc was the active and indefatigable supporter of our constitution in church and state. His talents were always exerted in the cause of religion and morality, and his life exemplified every virtue which his writings are designed to inculcate. There may be mistakes in some parts of his system, but those who knew the *man*, as I had the happiness of knowing him, may venture to answer for the intentions of the *author*; of whom his opponent, M. Le Tellier, thus expresses *his* opinion: "Je vous respecte comme grand Geologue, et comme ami et défenseur zélé du Christianisme."

We do not hesitate a moment to give the preceding communication, word for word, as we received it; and we are equally ready to express our full conviction that De Luc's *intentions* were as right-minded as our valued correspondent represents them to have been. We are not, however, so fully convinced, that, in the passage which has called for the preceding animadversions, he is not reprobated "with just severity." That Mr. Penn has not misunderstood it, for want of a sufficient knowledge of French, may be pretty confidently assumed by any one who has read his "Comparative Estimate," than which, we have met with very few works that evince a more perfect acquaintance both with modern and dead languages. Has he misrepresented it, then? We think not.—What can "des expressions" refer to, but the word *créées*, with or without its *ainsi*, as you please? It is the only word in the sentence about which any misunderstanding can by possibility exist. Had De Luc written, Je ne dirai pas qu'ils ont été *formés* ainsi, would he have thought it necessary to give his reason for declining the phrase? The question is, were the mountains originally formed as they

now are, *crées ainsi?* or are they the result of a chymical crystallization from a chaos, or heaven knows what? De Luc would not undertake to say they were *created thus*, because it is an expression about which men are not agreed; that is, men are not agreed as to what is, and what is not, a *creation*, and therefore he declined to use the term. But whether Mr Penn (and we with him) has or has not misunderstood De Luc, we are sure that he has not *intentionally* done him injustice, (as indeed our correspondent admits;) and that the severity with which he felt it necessary in several instances, to comment on his writings, was painful to his own feelings. Witness the following passages, which we should have quoted in our late review of the "Comparative Estimate," had our space admitted of it. After another equally severe, and, in our opinion, equally just censure of De Luc's "daring and inerudite tampering with texts of Scripture," by which he interprets the six days of creation not to be "days of twenty-four hours, but periods of undetermined length," Mr. Penn adds, "It is not without sincere pain that I feel myself compelled thus strongly to censure this particular work * of the able and amiable De Luc; but in so sacred a cause, there may be no complimentary reservation from man to man. He has himself rendered it indispensably necessary that a strong and effectual caution should accompany his writings; because they tend to dissolve the foundations of the edifice, which they officiously offer to secure. They are calculated, therefore, to produce an evil which no hostile assault could effect; for they are calculated to attract a confidence, which an hostile demonstration would repel. De Luc designed friendship; but, unfortunately, the execution of his friendly design is real hostility. He was eminently distinguished, and his memory is deservedly honoured, in the department of *physics*; he was great, also, in shewing the concord of many *natural phenomena* with the Mosaic record of *the Deluge*; but there was, the *limit* of his *true geology*. As soon as he attempted to proceed farther, and to argue *the mode of the first formation of this globe*, his mind lost its guide; he strayed *ultra crepidam*; and he brought himself into the same predicament with those whom he had before refuted and condemned in the article of *the Deluge*. The *measures of time* which he had philosophically denied to them, he now unphilosophically and inconsistently demanded for himself; they could not explain the *revolution* of this earthly system, without the aid of exorbitant measures of time which the Mosaic record refused them; and *he himself* could not understand the Mosaic description of the *creation* of this system, without exacting measures equally exorbitant, and equally refused by the record."—P. 208. "The general discernment and assertion of the great fact of *the Deluge*, was the bright point in his (De Luc's) geology. So long as his view was confined to the contemplation and exposition of that fact, his mind was collected and concentrated†. When he quitted it, to put himself in search of *the mode* by which *secondary causes* produced *first formations*, it became perplexed and bewildered‡. So long as he confined himself to the defence of that strong part, he evinced great skill, conduct, and resolution."—P. 273. "Thus much it has been indispensably necessary to expose as a cautionary distinction, and to insist upon, relative to this well-intentioned but dangerous instructor, lest his success in the *one argument* should become a snare to draw his readers into his own failure in the other."—P. 274.

We could quote many other passages in point, but it is unnecessary. We highly respect the feelings that have induced our correspondent to stand forward in defence of a man, at once eminent as a philosopher, and endeared by a long and ardent friendship. If we have joined with Mr. Penn in censuring some of his opinions, it is because we feel with him, that in so sacred a cause there may be "no complimentary reservation from man to man:" if those we entertain militate against the opinions of some other persons whom we highly honour, we may lament the discrepancy; but the same feeling forbids us to surrender our judgment, till *convinced* that it is erroneous. The sentiments we lately expressed, of Mr. Penn's "Comparative Estimate," we still retain, and shall continue to retain them till we see his arguments refuted by abler arguments, and his hypothesis subverted by one more consistent, *physically and morally*; with established facts, and the sacred record of the Bible.

* *Lettres Géologiques.*

† *Lettres sur l'Histoire de la Terre.*

‡ *Lettres Géologiques.*

ART. XIII. ASTRONOMICAL AND NAUTICAL COLLECTIONS.

No. XIV.

i. *The Resistance of the Air, determined from Captain KATER's Experiments on the Pendulum.*

THE effect of resistances of various kinds on the vibrations of the pendulum is become a subject of increased importance: from its influence on the determination of a standard measure: for although the effect of these resistances on the time may be wholly inconsiderable, it is by no means superfluous to prove, by demonstrative evidence, that they are actually insensible.

A constant resistance, and a resistance proportional to the square of the velocity, produce either no change at all of the time of vibration, or an infinitely small change when the arc is infinitely small: but a resistance simply proportional to the velocity, if it be at all considerable, may produce a sensible retardation, even in an evanescent arc. It becomes, therefore, of some importance to inquire, what is the law of the resistance to very slow motions; and the elaborate experiments of the indefatigable Captain Kater will afford us the information that is required for establishing, in this respect, the sufficiency of the superstructure that has been built on them. It is, however, necessary, to take the mean of a large number of separate registers of observations, in order to investigate the laws of the retardation: for the question is so delicate, that the results of any small number of experiments might lead to very erroneous conclusions: but when properly analysed, the experiments, related in the third part of the *Philosophical Transactions* for 1819, are amply sufficient to show that a certain portion of the resistance to the motion varies simply as the velocity; and that it cannot be correctly expressed, as Mr. Gilbert has supposed, by a constant term and a term proportional to the square of the velocity only. Sir Isaac Newton, indeed, has hinted in the *Principia*, that a constant term, expressing the resistance derived from the thread suspending his pendulum, with another term proportional to the square

of the velocity, might be sufficiently accurate for the purpose : and Euler has inferred, from Newton's experiments, that the constant resistance of the air to the motion of a leaden ball, two inches in diameter, was about one millionth part of its weight, or that it would cause it to remain at rest at an angular deviation of $0''.2$ from the vertical line : but a part at least of this resistance may perhaps have been derived from the want of flexibility or elasticity of the thread.

From a mean of 60 experiments of Captain Kater, consisting of about 5000 vibrations each, we obtain $1^\circ.185$, $1^\circ.086$, $0^\circ.997$, $0^\circ.919$, and $0^\circ.843$ for the successive values of the arcs, at intervals of about 960 vibrations : and a slight irregularity in the second differences of these numbers makes it probable that .997 ought to be altered to .998. With this correction, the successive diminutions, in about 1920 vibrations, will be .187, .167, and .154, for the respective arcs of intermediate values, each of which must be supposed to exceed the intermediate arc actually observed by one third of its deficiency below the mean of the two neighbouring numbers, and we may call them 1.088, 1.000, and .9195, respectively.

Putting then $D = x + Ay + A^2z$, for the diminution of the arc, we have three equations, the last of which, subtracted from the first, gives us $.1685 (y + 2.1075 z) = .033$, and $y + 2.1075 z = .1958$; consequently, if $z = 0$, $y = .196$, which would be the coefficient for a resistance simply proportional to the arc, giving $x + .196$ for the amount of the second diminution, that is, .167; so that x would require to be negative, which is impossible : and if $y = 0$, $z = .093$, and the second diminution would require x to be .074: a value which is sufficiently compatible with these equations, but which would not be applicable to the shorter vibrations ; an arc of $0^\circ.80$, for example, exhibiting a diminution of about .11, and leaving only about .050 for x , so that x must probably be still smaller than .05, and if we make it $= .040$, we shall have .127 left for $y + z$, and $.196 - .127 = .069 = 1.1075 z$, and $z = .062$, and $y = .065$, and $D = .040 + .065 A + .062 A^2$, which gives .132 for an arc of .8, and x is still too large. Now, if we take

x somewhat smaller, we shall reduce the expression to a perfect square, and we shall find that $(.16 + .25 A)^2 = .0256 + .080 A + .0625 A^2$ will represent the diminution with great accuracy, giving .187, .168, and .152, for the respective arcs of 1.09, 1.00, and .92: and this expression has the advantage of affording a very easy integration for the arc.

For, if t be the number of vibrations divided by 1920, we have $-dA = (.16 + .25A)^2 dt$, and $\frac{-dA}{(.16 + .25A)^2} = dt$: but

$$d \frac{1}{.16 + .25A} = \frac{-.25dA}{(.16 + .25A)^2}, \text{ and } \frac{4}{.16 + .25A} = t + c \text{ or}$$

$$.16 + .25A = \frac{4}{t + c}, \text{ and } .64 + A = \frac{16}{t + c}: \text{ whence, putting}$$

$$\widehat{.64 + A = B}, \text{ and its initial value } b, b = \frac{16}{c}, \text{ and } c = \frac{16}{b};$$

$$\text{consequently } B = \frac{16}{\frac{16}{b} + t}, \text{ and } \frac{1}{B} = \frac{1}{b} + \frac{t}{16}.$$

In many of the series of experiments, it is necessary to make some variation in the constant coefficients, on account of the state of the atmosphere, and we may take in general $B = A + C$, and $\frac{1}{B} = \frac{1}{b} + \frac{t}{q}$, the factor q , in the case already computed,

being made either 16, or 16×1920 , accordingly as we wish to take the interval of the coincidences for the unit of time, or to express it in seconds; and C , in some of the series of experiments, appearing to be about 1° or even 2° , instead of $0^\circ.64$. The supposition of $C = 1^\circ$ is equivalent to that of $D = .04 + .04 A + .01 A^2$, q becoming in this case 25.4 instead of 16. The constant part of D , expressed by x , causes in half a vibration a retardation of $\frac{1}{3840} x = 0^\circ.000067 = 0'.004 = 0''.24$,

which happens to agree singularly well with the $0''.20$ deduced by Euler from Newton's experiments.*

We may easily compute, from the value of A thus determined, the total retardation depending on the vibration in a circular

curve, which is expressed, for a small arc of vibration, by one-eighth of the verse sine, the whole time of the vibration being unity, or, for the arc A , since the verse sine of 1° is .000152, by very nearly .000019 A^2 ; and the fluxion of the time being dt , that of the circular excess will be as $A^2 dt = (B - C)^2 dt = C^2 dt - 2BC dt + B^2 dt$: now $\frac{b}{B} = 1 + \frac{b}{q}t$ or $= 1 + pt$,

putting $p = \frac{b}{q}$, and $B = b \frac{1}{1 + pt}$, and $\int \frac{dt}{1 + pt} = \frac{1}{p}$

hl $(1 + pt)$, consequently the fluent of the second term is $- 2C \frac{b}{p} \text{hl} (1 + pt) = - 2Cq \text{hl} \frac{b}{B}$; that of the third, or

$\frac{bb}{(1 + pt)^2} dt$, being, when corrected, $\frac{bb}{p} \cdot \frac{pt}{1 + pt} = b^2 \frac{t}{1 + pt} = b^2 t \frac{B}{b} = bBt$; so that the whole circular excess will be-

come .000019t $(C^2 - 2C \frac{b}{pt} \text{hl} (1 + pt) + \frac{bb}{1 + pt})$ or .000019t $(- .41 - 1.28 \frac{q}{t} \text{hl} \frac{b}{B} + bB) = .00001 (1.9bB$

$- 2.432 \frac{q}{t} \text{hl} \frac{b}{B} + .779.)$ Taking for example, Captain

Kater's first register of experiments, in which $a = 1^\circ.38$, and $A .92$, when t was $\frac{5}{2}$, so that $\frac{b}{B}$ being $\frac{2.02}{1.56} = 1.2949 =$

$1 + \frac{b}{q}t = 1 + \frac{5.05}{q}$; we must here make $q = \frac{5.05}{.2949} =$

17.124, and $\frac{q}{t} 6.850$, and $\text{hl} \frac{b}{B}$ being $= .7031 - .4447 =$

.2584, the whole is .00001 $(5.987 - 4.304 + .779) t = .00002462$, or 2.12 in 86050 vibrations; which agrees exactly with Captain Kater's computation from the separate arcs observed.

If we adopted the Newtonian hypothesis of a resistance mea-

sured by $m + n A^2$, we should have $\frac{-dA}{m + nA^2} = dt$, and $t = -\sqrt{\frac{1}{mn}} \arctan\left(\sqrt{\frac{n}{m}} A\right)$, consequently $\sqrt{(mn)} t = -\arctan\left(\sqrt{\frac{n}{m}} A\right)$, and $\tan \sqrt{(mn)} t = -\sqrt{\frac{n}{m}} A$ and $A = -\sqrt{\frac{m}{n}} \tan(\sqrt{(mn)} t) + c$; and, for the correction of the fluent, $a = +c$, and $A = a - \sqrt{\frac{m}{n}} \tan(\sqrt{(mn)} t)$.

There appears to be an oversight in a remark inserted among the *Elementary Illustrations of the Celestial Mechanics*, p. 145; where it is observed that "the whole time of the oscillation can never be sensibly affected by any small resistance proportional to the velocity;" for, in fact, the coefficient γ , in the expression of Laplace, being equal to $\sqrt{k - \frac{mm}{4}}$, is in some degree

affected by m , which expresses the resistance; and the time is affected by γ , though Laplace has not investigated the precise effects of a given resistance. That which is here inferred from Captain Kater's experiments, however, would scarcely produce a retardation of one fiftieth of a second in a year: and must, therefore, be wholly neglected.

If we are anxious to reconcile the existence of a retardation proportional to the velocity, with the common theory of the impulse of fluids, it will not be difficult to understand how the one may possibly be derived from the other. We have only to suppose the pendulum subjected to the influence of a very slow current of air, in order to deduce a resistance nearly proportional to the velocity v from another, which depends on $(c \mp v)^2$. For it will appear, by considering the directions of the forces concerned, that at the extremities of the vibration, while the velocity of the current exceeds that of the pendulum, and $c - v$ remains positive, the quantity $2cv$ will denote a retarding force throughout the motion, and that the portions c^2 and v^2 will be retarding in one direction and accelerating in the other, and will have no sensible effect on the extent of the vibrations;

while, on the other hand, if the velocity of the pendulum towards the middle of the vibration exceeds that of the current, the force $2cv$ will retard the motion in one direction, and accelerate it in the other, leaving only the constant resistance c^2 , and the variable quantity v^2 , which is proportional to the square of the velocity. We obtain, therefore, for the extremities of the vibrations, a force proportional to the simple velocity, and for the middle, a constant resistance, and another force varying simply as the velocity, the joint effect of all which must be a resistance nearly such as has been inferred from Captain Kater's experiments, if the current moved at the rate of about half an inch in a second, which would have been scarcely perceptible to the senses.

The question, however, regards not so much the distribution of the resistance through the different parts of a single vibration, as its comparative value for the mean velocities of the successive vibrations. Now, if the velocity of the current always exceeds that of the pendulum, the only effective resistance will be proportional to the simple velocity; and when it is smaller than the greatest velocity of the pendulum, the resistance will approach more and more to the ratio of the square of the velocities increased by a constant quantity; and supposing the velocity of the current to remain small and nearly uniform, while the arc of vibration considerably diminishes, the whole resistance will at first be more nearly as the square of the arc, and if the arc be sufficiently diminished, the resistance proportional to the simple velocity will at last remain alone. Hence, it is easy to understand the variation of the constant coefficients in the different series of Captain Kater's experiments.

12 April, 1823.

ii. *Extract from a Letter to Professor SCHUMACHER, relating to BESSEL's Refractions.*

I do not quarrel with you for your confidence in Bessel: but I think you have not sufficiently attended to the limitation under which he himself originally published his Theory of Refraction, Fundam. p. 55. "*In distantius à vertice non super-*

antibus 86° , *tabulæ meæ, ut docet allata comparatio, prorsus cum observationibus Bradleianis congruunt.*" And, in fact, the mean errors, as deduced from his own computations, p. 53, are these :

Zenith Distance	89°	$28'$	Error	$+ 37''.0$
	88	40		$+ 10.7$
	88	13		$+ 11.1$
	87	34		$+ 4.0$
	87	24		$+ 2.7$
	87	9		$+ 4.7$

We may also consider Mr. Delambre's authority as amply sufficient for the refraction at the horizon, which he makes $33' 46''.3$, from *several hundred* observations, made at Bourges, from 70° to $90^{\circ} 20'$ zenith distance. Now Bessel's table gives, for the horizon, about $36' 30''$; that is, $2' 44''$ too much.

It may be said that these errors afford no *practical* objection to the table, because observations are very rarely made at such altitudes : but surely they are objectionable in a *theoretical* point of view, since it is only the extreme cases that afford any test of the truth of the theory : for in common cases, all theories agree sufficiently well ; and in fact, Mr. Bessel's supposition, that the density is so related to the height s as to be expressed by e^{-nas} , is contrary to all experience with respect to the distribution of temperature in the atmosphere.

I have to thank you for your Auxiliary Tables for 1823 ; but I must enter my formal protest against the decided manner in which you mention the differences between the declinations of Greenwich and of Königsberg.

* * *

iii. *Specimen of Mr. STOCKLER's Inverse Method of Limits. In a Letter to CHARLES BABBAGE, Esq., F.R.S.*

DEAR SIR,

I have received from Mr. Stockler the manuscript of a work in Portuguese, dedicated to the Royal Society, and entitled *Methodo Inverso dos Limites*. I do not know that there is any immediate probability of its being made public : but I wish to ask your opinion of the degree of utility that is to be expected

from these investigations, as far as you can judge from the specimen which I send you, containing what the author considers as the fundamental proposition of his method; a method of which the object can only be, as he observes, "to determine the law or the form common to all the series of which a given function can be the limit of expression; and which is therefore reducible to the solution of this single

PROBLEM.

Supposing x to be any function of any number of variable quantities, and representing by Fx any function of x , and consequently of the same variable quantities that enter into the expression of x ; to determine the form, or the general law, common to all the series of which Fx can be the limit of expression.

SOLUTION.

Taking any state whatever of the magnitude of x to serve as a term or limit, to which all the others may be referred, we shall designate it by the name of the *Primitive State*, and all the others by the denomination of *varied* or *derivative states*. Then representing by x the primitive state of the quantity or function indicated by x , and any of its derivative states by $x + u$, we shall have Fx for the primitive state of the function of x indicated by the characteristic F , or the magnitude of Fx corresponding to the primitive state of the function represented by x , and $F(x + u)$ will represent the magnitude of Fx corresponding to $x + u$. Now, as the increment u is absolutely arbitrary, we may consider it as capable of admitting states of magnitude less than any other that may be assigned: and, therefore u is a variable without any limit to its diminution; whence it follows that $x = \lim (x + u)$; and $Fx = \lim F(x + u)$. It may, consequently, be inferred that $F(x + u)$ must be equivalent to Fx more or less a function of x and u , or of u only, without limit to its diminution; so that, considering the most general form of $F(x + u)$ after its separation into two parts, we shall have

$$F(x + u) = Fx + VF'(x, u)$$

V being a function of u without limit to its diminution, an

$F'(x, u)$ a function of x and u capable of limitation. For the same reason, keeping always in view the most general form of the functions of x and u , we must have

$$F'(x, u) = F' x + V' F''(x, u),$$

$$F''(x, u) = F'' x + V'' F'''(x, u).$$

$$F'''(x, u) = F''' x + V''' F''''(x, u), \&c.$$

V' ; V'' , &c., being functions of u without limit in diminution, and $F''(x, u)$; $F'''(x, u)$; &c., functions of x and u capable of limitation. Now the first of these conditions cannot be expressed in a more general manner, than by making

$$V = u \phi u.$$

$$V' = u \phi' u.$$

$$V'' = u \phi'' u, \&c.$$

expressions in which ϕu ; $\phi' u$; $\phi'' u$, &c., represent functions of u capable of limits, or constant quantities: and the substitution of these values, in the former equations, reduce them to

$$F(x+u) = F x + u \phi u F'(x, u).$$

$$F'(x, u) = F' x + u \phi' u F''(x, u).$$

$$F''(x, u) = F'' x + u \phi'' u F'''(x, u), \&c.$$

and the substitution of each of these in the others gives us finally,

$$F(x+u) = Fx + u\phi u F'x + u^2\phi u \phi' u F''x + u^3\phi u \phi' u \phi'' u F'''x + \&c.$$

or, if we write x for u , and u for x , which in no way changes the function $F(x+u)$.

$$F(u+x) = Fu + x\phi x F'u + x^2\phi x \phi' x F''u + x^3\phi x \phi' x \phi'' x F'''u + \&c.$$

If we here observe, that u has no limit of diminution, and if we denote by $F0$, $F'0$, $F''0$, &c., the limits of Fu , or the values to which these functions are reduced by the substitution of a zero for the symbol denoting its root, we shall obtain ultimately from this formula the following equation.

$$Fx = F0 + x\phi x F'0 + x^2\phi x \phi' x F''0 + x^3\phi x \phi' x \phi'' x F'''0 + \&c.$$

and in this most general expression consists the solution of the problem proposed.

In the subsequent sections the author proceeds to introduce more particular values, for such of the quantities as here remain indeterminate: but you will be able to judge of the method that he employs by the first section, of which I have given you a

translation. For my own part, I think that the substitution of $F'(x,u)$ in an argument inferred from reasoning on $F(x+u)$, as well as the exchange of x for u and u for x , when u only had before been supposed evanescent, requires something more of illustration than the learned and accomplished author has here thought it necessary to bestow on it, though I am not at all disposed to deny the general validity of his reasoning, or the truth of his conclusions.

Believe me, dear Sir,

Yours, very sincerely,

London, 19 May, 1823.

* * *

iv. *An easy Method of computing the Time of Conjunction in Right Ascension from an observed OCCULTATION.*

I. Observe, if possible, the difference of apparent altitudes at the time of immersion, or emersion; if not, compute it either by finding the altitudes separately, or from the differences of declination, and right ascension, allowing for the change of declination between the conjunction in right ascension at Greenwich, and the time of immersion, by reckoning; and reducing the difference of declination in the ratio of the radius to the cosine of the parallactic angle ($P\Delta Z$), and that of right ascension in the ratio of the radius to the cosine of the same angle. (See *Astr. Coll.* No. III.)

II. The true distance at the time of immersion may be found, as in the correction of a lunar observation, by the method in the Appendix to the Requisite Tables, observing that the Reserved Logarithm will become simply $\log. (\cos. P' - \sin. A' \sin. P)$, P being the horizontal parallax, P' the parallax in altitude, and A' the apparent altitude. This multiplier, however, may be altogether omitted without inconvenience, and the triangles may be treated as plane instead of spherical, the square of the true distance being equal to the sum of the squares of the semi-diameter and of the difference of true altitudes, lessened by the square of the difference of apparent altitudes.

III. The square of the true distance being thus obtained, the distance of the star from the orbit may be found by reducing the difference of declinations at its conjunction in right as-

cension, in the ratio of the radius to the sine of the orbital angle; and the square of the nearest distance, being subtracted from the square of the true distances, will give the square of the distance from the point of the orbit nearest to the star, the place of which in the orbit is found from the cosine of the orbital angle. And in all these cases, the natural verse sines, taken from a good table, will serve instead of the squares. The time of immersion is found from the place in the orbit by means of the hourly motion, and may be employed for correcting the declination, and repeating the operation, when necessary.

I. *Example.* Suppose the emersion of $\nu \Omega$ to have been observed at Paris, 1822, Feb. 8, $10^h 9^m 11^s$: and the difference of altitudes of the star and the moon's centre, either observed or computed, to have been $2' 36''$: the semidiameter at the time being $15' 18''$, and the parallax in altitude $52' 1''$, whence the true difference of altitudes was $54' 37''$, the star being below the moon's centre.

II. The semi-diameter	$15' 18'' = 918$	square	842724
True diff. alt.	$54' 37'' = 3277$		10738729
Diff. app. alt.	$2' 36'' = 156$	A.C.	99975664
True distance	$56' 40'' = 3400$		11557117

III. Now in order to find the point of the orbit nearest to the star, we take the difference of declination at the conjunction, P. L. $41' 58''$.

			.6324
And add to it the log. cosec.	$62^\circ 2'$	{	.0539
and the log. sec.			.3289
Hence the distance is	$37' 4''$	}	.6863
the motion in the orbit	$19' 41''$		.9613
Then	$37'.4'' = 2224''$	square	4946176
Subtracted from			11557117
Gives	$42' 51'' = 2571$		6610941
Deduct	$19' 41''$		

the remainder $23' 10''$ is the motion in the orbit, which, at the rate of $31' 30''$ in an hour, gives $44^m 8^s$, to be added to the time of emersion, $10^h 9^m 11^s$, for the time of conjunction in right ascension, making $10^h 53^m 19^s$; which differs only by a second from the true term of conjunction, $10^h 53^m 18^s$.

A table of square numbers, like that of Professor Barlow, will be found very useful in these computations.

v. *Remarks on Mr. PLANA's Researches relating to Refraction.*

In a Letter to Professor GAUTIER.

MY DEAR SIR,

I believe it is to you that I am indebted, or perhaps to Baron Zach, for the notice that Mr. Plana has been pleased to take of my papers on Refraction: and I consider myself as obliged to this justly celebrated mathematician, not only for the flattering terms in which he has mentioned my name, but also for the forbearance with which he has hinted at what appears to him to be an unfounded objection to Laplace's hypothesis; at the same time, that he has endeavoured to substitute another objection to that hypothesis, which will, perhaps, be still more easily superseded. I hope also to be allowed, in return for these services, to set Mr. Plana right upon a point of physical optics, respecting which he is both essentially and accidentally in error: essentially, because, he mistakes the ground upon which I have founded my optical reasoning; and accidentally, because the error, if it had existed, would have been of no consequence whatever to the result.

I might, perhaps, be justifiable in complaining, that in a section devoted to the history of the late researches on refraction, Mr. Plana has only mentioned my attempts, in order to express his surprise at this supposed error, and that he has not thought it necessary to take the slightest notice of the real innovation that I have ventured to make in the investigation. The history of my paper might have been expressed very shortly, by saying that it was "a Method of computing the Atmospheric Refraction, upon any possible hypothesis, by means of a series which expresses the density in terms of the integer powers of the refraction itself; a series converging rapidly in all ordinary cases, and converging sufficiently, even in the extreme cases near the horizon. Mr. Plana not having noticed this distinguishing characteristic of my little invention, I shall endeavour to impress it on his mind, by one more instance of the facility with which it may be employed; and I shall offer him, for this purpose, an

example of its application to the hypothesis of Laplace, which is expressed in so intricate a form, as not to be of the most manageable nature, and as to be very liable to some misinterpretations.

My series, as it was actually employed for the construction of the table printed in the *Nautical Almanac*, (*Astr. Coll.* VIII.

iii.) is $A = v \frac{r}{s} + (B - \frac{1}{2} s^2) \frac{r^2}{s^2} + Cv \frac{r^3}{s^3} + \frac{1}{2} C(B - \frac{1}{2} s^2) \frac{r^4}{v^4}$; and I have demonstrated that A being $= p$, and $\zeta =$

$\frac{dy}{dz}$, and $\zeta' = \frac{d\zeta}{dr}$, B must be $\frac{\zeta v}{2mp}$, and $C = \frac{1}{6} \left(\frac{\zeta s}{mpv} + \frac{\zeta}{mp^2} \right)$, whatever may be the relations between the density z ,

and the pressure y : and if we put $\xi = \frac{d\zeta}{dx}$, we shall have, still

more compendiously, $C = \frac{\zeta}{6mp^2} \left(1 + \frac{\xi}{m} \right) = \frac{B}{3p} \left(1 + \frac{\xi}{m} \right)$;

since $\frac{dx}{dr} = \frac{\zeta v}{mps}$, and $\zeta' = \frac{\xi \zeta v}{mps}$.

Now in the hypothesis of Laplace, (*Méc. Cél.* X. §. 7. P. 264),

" $u = s - 0,000293876 \left(1 - \frac{\varepsilon}{(e)} \right)$; $\varepsilon = (\rho) [1 + u. 661,107]$

$e^{-u.1348,04}$;" or, in the symbols of the series, " u " $= 1 -$

$\frac{1}{x} - p(1 - z)$, and $z = (1 + \mu u) e^{-\nu u}$; making $661,107 =$

μ , and $1348,04 = \nu$.

Hence, we obtain $du = \frac{dx}{xx} + pdz$, and $dz = \mu e^{-\nu u} du -$

$\nu z du$; and making $\mu e^{-\nu u} - \nu z = U$, $dz = U du = U \frac{dx}{xx} +$

$p U dz$, $dz - p U dz = U \frac{dx}{xx}$, and $dz = \frac{U}{1 - pU} \frac{dx}{xx}$: and dy

being $= -mzdx$, $\frac{dy}{dz} = \zeta = -mx^2 \left(\frac{1 - pU}{U} \right) = mx^2 \left(p -$

$\frac{1}{U} \right)$; consequently $d\zeta = 2 \frac{\zeta}{x} dx + mx^2 \frac{dU}{UU}$; $-mx^2 \frac{dU}{UU}$;

but $dU = -\mu v e^{-vu} - v dz = -\mu v e^{-vu} \frac{dz}{U} - v dz$: and initially, when $u = 0$, $U = \mu - v$, $dz = \frac{U}{1 - pU} dx$, or if $v = \mu$

$$= \lambda, dz = \frac{-\lambda}{1 + p\lambda}, \zeta = mp + \frac{m}{\lambda}, dU = \mu v \frac{dz}{\lambda} - v dz =$$

$$- \mu v \frac{dx}{1 + p\lambda} + \frac{v\lambda}{1 + p\lambda} dx, \text{ and } \frac{d\zeta}{dx} = \xi = 2\zeta + \frac{m}{\lambda\lambda}.$$

$$\frac{v\lambda - \mu}{1 + p\lambda} = 2\zeta + \frac{m}{\lambda\lambda} \cdot \frac{\lambda - \mu}{1 + p\lambda} = 2\zeta + \frac{m}{\lambda\lambda} \cdot \frac{v - 2\mu}{1 + p\lambda}.$$

The numerical values of the coefficients, taking $m = 798$, as supposed by Laplace, will be $B = \frac{\zeta}{2mp} = \frac{1}{2} + \frac{1}{2p\lambda} = \frac{1}{2} + \frac{3403}{1373.86}$

$$= 2.977, \text{ and } C = \frac{B}{3p} \left(1 + \frac{\xi}{m}\right) = \frac{B}{3p} \left(1 + \frac{2\zeta}{m} + \frac{v}{1 + p\lambda} \cdot \frac{v - 2\mu}{\lambda\lambda}\right) = \frac{.9923}{p} \left(1 + .0074 + \frac{1348 \times 25.82}{1.2019 \times 687 \times 687}\right) =$$

3141 (1.0074 + .0614) = 3141 $\times$ 1.0688 = 3356. In the *Nautical Almanac*, the values, obtained from the observed refractions only, are $B = 2.97$ and $C = 3600$: and the difference in the results of the computation will be insignificant even at the horizon.

It is almost unnecessary to remark, that a hypothesis, so well supported by direct observation, can scarcely be very materially erroneous. With respect to the variation of temperature in ascending, we may represent it by making $z = y(1 + tx - t)$; (*Collect.* VI. i. 7. D.); t being either constant or variable, according to the conditions of the hypothesis; then if f be the number of feet required for a depression of a degree of Fahrenheit, we shall have $t = \frac{20\,900\,000}{476f}$, and $f = \frac{43907}{t}$; but

$$dz = dy \frac{z}{y} + ty dx + (x - 1) y dt; \text{ consequently } t = \frac{dz}{y dx}$$

$$- \frac{z}{yy} \frac{dy}{dx} - (x - 1) \frac{dt}{dx}, \text{ and } dt = d \left(\frac{dz}{y dx} - \frac{z}{yy} \frac{dy}{dx} \right)$$

$$\begin{aligned}
& - dt; \text{ whence } 2dt^{\vee} = d \left(\frac{dz}{ydx} - \frac{z}{yy} \frac{dy}{dx} \right); \text{ and since } \frac{dy}{dx} \\
& = \frac{\xi dx}{dz} - mz, dt^{\vee} = \frac{1}{2} d \left(\frac{mzz}{yy} - \frac{mz}{y\xi} \right) = \frac{m}{2} d \left(\frac{zz}{yy} - \right. \\
& \left. \frac{1}{\xi} \frac{z}{y} \right) = 2d \frac{z}{y} - \frac{1}{\xi} d \frac{z}{y} - d \frac{1}{\xi}; \text{ but } d^{\vee} \frac{z}{y} = dz - \\
& dy = (1 - \xi) dz, \text{ and } -d \frac{1}{\xi} = \frac{d\xi}{\xi\xi} = \frac{\xi dx}{\xi\xi} = -\frac{\xi dz}{m\xi}, \\
& \text{ and } \frac{dt^{\vee}}{dz} = \frac{m}{2} \left(2 - 2\xi - \frac{1}{\xi} + 1 - \frac{\xi}{m\xi} \right) = \frac{m}{2\xi} (3\xi - 2\xi^2 \\
& - 1 - \frac{\xi}{m}). \text{ Now we have found } \xi \text{ in the present case} = 1.396, \\
& \text{ and } \frac{\xi}{m} = .0688; \text{ whence } \frac{dt^{\vee}}{dz} = \frac{m}{2\xi} (4.188 - 3.898 - 1 \\
& - .069 = - .779 \frac{m}{2\xi}; \text{ which being negative, it follows that } t
\end{aligned}$$

increases with the elevation, as z diminishes, and that the variation of temperature becomes greater in ascending.

Mr. Plana has remarked, that “ en suivant les conséquences de l’hypothèse de M. de Laplace, l’on pourrait ajouter, que la pression barometrique, qui *en résulte*, est loin de s’accorder avec celle *observée* par M. Gay-Lussac au point supérieur de son ascension aérostatique.” I shall not undertake to criticize Mr. Plana’s Memoir, especially without having had time to read it through with attention; but I am utterly at a loss to conceive by what witchcraft he has been able to compute the barometrical pressure *resulting* from Laplace’s hypothesis at the height attained by Gay-Lussac, if that height was only deduced from the actual observation of the *barometer*. Perhaps, indeed, the aéronauts were able to measure, with their sextant, a variety of angles, subtended by distant terrestrial objects: and if such was the fact, my question is answered.

I shall now proceed to discuss the second passage in which Mr. Plana has done me the honour to mention me. “ Je crois avoir reconnu,” he observes, (p. 301), que le Dr. Young n’est pas parti de la véritable équation du problème dans un de ses

écrits, ayant pour titre *Corrections for Refraction*, Le D. Y. après avoir pris pour base cette équation très exacte [$d\theta = \frac{du}{\sqrt{(r^2 - u^2)}}$], donnée antérieurement par *Lambert*, suppose la

perpendiculaire u , dans la courbe décrite par le corpuscule de lumière, telle que l'on a $u = \frac{b}{1 + M_\epsilon}$, b étant un constant convenable." This value of u is inconsistent, he observes, with the

demonstration of Laplace and others, and he continues ; " Pour redresser cette erreur, il faut supposer à la variable u une expression de la forme $u = \frac{b}{\sqrt{(1 + M_\epsilon)}}$... Cette méprise du Dr.

Young est tellement singulière, que je crois de mon devoir de rapporter ici le raisonnement même que ce physicien... a fait pour établir son expression différentielle de la réfraction." In the passage quoted, I have called the refractive density $1 + pz$, " p being a *very small* fraction."

Mr. Plana does not seem to be aware that, in the theory of optics, which I have long since advanced, and which has of late years begun to acquire some considerable popularity, the demonstration, to which he alludes, as deduced from the laws of central forces, is wholly inadmissible, except as a mathematical fiction : and he must show, that the refractive density does *not* vary in proportion to the actual density multiplied by a very small fraction, and increased by unity, before he can establish this charge. But even supposing it established, that I ought to have taken $\sqrt{(1 + M_\epsilon)}$ instead of $1 + p_\epsilon$, it is quite clear, that since $\sqrt{(1 + M_\epsilon)} = 1 + \frac{1}{2} M_\epsilon - \frac{1}{8} M^2 \epsilon^2 \dots$ and since ϵ is always less than unity, the error could only amount to $\frac{1}{8}$ of the square of the coefficient M , that is, to the square of

$\frac{1}{1700}$, and that such an error would have been wholly insensible.

Believe me, dear Sir, yours, very sincerely,

9 June, 1823.

* * *

ART. XIV.—MISCELLANEOUS INTELLIGENCE.

I. MECHANICAL SCIENCE.

1. *Bridge at Menai Straits.*—The first great iron plate for forming the fastening of Menai bridge was laid in its proper position in the bottom of one of the caverns which had been formed out of the solid rock on the Anglesea shore, on Easter Monday. Sir Henry Parnell and Mr. Telford attended on the occasion, and did not leave until all the necessary arrangements were adopted for proceeding immediately with the putting up of the large quantities of the iron-work which have arrived from Shropshire, for forming the suspending cables. Nearly the whole of the bridge masonry is completed, the pyramids for supporting the cables of 50 feet in height above the top of the main piers will be finished early in summer, and the iron-work is going on so rapidly at Mr. Hazeldine's forges, that there is a certainty of this great work being completed in the most satisfactory manner for the use of the public, in little more than another year.

2. *Gas Lighting.*—The length of streets already lighted in this metropolis with gas is 215 miles ! and the three principal companies light 39,504 public lamps, and consume annually about 33,158 chaldrons of coals.

3. *Artificial Formation of Haloes.*—The following experiment, which illustrates in a pleasing manner the actual formation of haloes, has been given by Dr. Brewster. Take a saturated solution of alum, and having spread a few drops of it over a plate of glass, it will rapidly crystallize in small flat octoëdrons scarcely visible to the eye. When the plate is held between the observer and the sun or a candle, with the eye very close to the smooth side of the glass plate, there will be seen three beautiful haloes of light at different distances from the luminous body. The innermost halo, which is the whitest, is formed by the images refracted by a pair of faces of the octoëdral crystals, not much inclined to each other; the second halo, which is more coloured, with the blue rays outwards, is formed by a pair of faces more inclined; and the third halo, which is very large and highly-coloured, is formed by a still more inclined pair of faces. Each separate crystal forms three images of the luminous body placed at points 120° distant from each other in all the three haloes; and, as the numerous small crystals have their refracting faces turned in every possible direction, the whole circumference of the haloes will be completely filled up.

The same effects may be obtained with other crystals, and when they have the property of double refraction, each halo

will be either doubled when the double refraction is considerable, or rendered broader or otherwise modified in point of colour, when the double refraction is small. The effects may be curiously varied by crystallizing upon the same plate of glass crystals of a decided colour, by which means we should have white and coloured haloes succeeding each other.—*Edin. Phil. Jour.* viii. 394.

4. *On the Electricity produced by Pressure.*—A very important paper, on the developement of electricity by pressure, and the laws of that developement, by M. Becquerel, is to be found in the *Annales de Chimie*, xxii. 5. We cannot do more at present than translate the summary given at the conclusion of the paper.

It is seen, then, that all bodies assume two different electric states by pressure: that, in two bodies being perfect conductors, this state of equilibrium ceases, at the moment the pressure is removed, but if one be a bad conductor, the effect of the pressure continues for a longer or shorter time; that the pressure alone maintains the equilibrium of the two fluids, placed on each of the surfaces; for if the pressure be diminished, and, at the end of a certain time, the bodies be removed from the compression, they will be found to have the electricity, due only to the last or remaining pressure: that heat modifies the developement of electricity in a particular manner: that the intensity of the electricity increases, at first, directly as the pressure; and that it is probable this proportion diminishes at high pressures, as the bodies lose their power of being compressed: finally, it is rendered probable, that the light which is disengaged in powerful concussions, is due to the rapid recombination of the two electric fluids developed on the surfaces at the moment of compression.

5. *Light evolved by Pressure.*—We extract the following passage from the paper above referred to. Considering the increased developement of electricity in bodies, by the augmentation of pressure, ought we not to refer to this cause certain luminous phenomena, of which the origin is as yet unknown? For instance, it is said, that in the Polar Seas, it frequently happens, that the blocks of ice which strike together evolve light. These enormous blocks arriving one against the other, with considerable motion, will be submitted *to great pressure, and thus the two blocks be placed in two different electric states. At the moment the compression ceases, the two fluids will recombine, in consequence of the conducting power of the ice; and may not the light disengaged be the result of the combination of the electric fluids *?

* See also the light from the falling of a glacier, ix. p. 426.

Iron, submitted to successive blows, also becomes luminous. Are not the same electric phenomena of pressure produced here, as when two masses of ice strike together?

6. *Developement of Electricity by two pieces of the same metal.*—Among the applications of the electro-magnetic multiplier, is the following:—If two pieces of the *same* metal are plunged, at different moments, into an acid capable of acting on them, that which was first introduced will act as the most positive metal to the other. The experiment may be made very well with zinc and diluted muriatic, or sulphuric acid.—Avogadro, *Annales de Chim.*

7. *Variation of Thermometers.*—In the last volume of this Journal, p. 441, notice was taken of an observation made by M. Flaugergues on the instability of the freezing point of ice, as laid down on thermometers. The effect was not observed in alcohol thermometers or in mercurial thermometers open at the top, and was attributed to the gradual yielding of the glass bulb to the external atmospheric pressure, which, diminishing its bulk, raised the surface of the mercury in the tube, and rendered the scale incorrect.

M. Bellani has entered into the investigation of an analogous error in thermometers, and published the result of his researches in the *Giornale di Fisica*, v. 268. He finds that a mercurial thermometer, being made in the usual manner, and the freezing point of water marked on it from experiment, if it be laid aside awhile, and again plunged in melting ice, the mercury will stand higher than before; and that if it be put aside again, and then again tried, the mercury will be higher still, until, at the end of a certain time, a year or so, the effect of elevation will cease.

It was found from numerous experiments, that the result was not influenced by the various qualities of the glass used in the instrument; by the more or less perfect exclusion of air from the bulb or tube; by the constant horizontal, perpendicular, or inverted position of the instrument; by the open or closed extremity; by the longer or shorter time of remaining in the ice; or by the compression of the surrounding ice. Neither was it found to be peculiar to mercurial thermometers, but was exhibited by alcohol thermometers, though in a less degree.

M. Bellani at last ascertained, that the effect was due to a gradual and slow contraction of the glass after having been highly heated, which contraction, as long as it continued, diminished the bulk of the instrument, and consequently forced the fluid into the tube. This effect he illustrates in the following manner:—Take a Florence flask, or any similar thin glass vessel, such as a matrass with a long narrow neck, shortly after it has come from the glass furnace, it not having been annealed

in the oven ; introduce shot or sand into it till it almost sinks in water, seal it hermetically, and draw out one part of the neck until not more than a line in diameter, that part being about an inch in length ; fasten a small basin on the top of the neck with wax, and then, putting the instrument in water of a certain temperature, 40° F. for instance, put weights in the cup till the surface of the water is at the middle of the narrow part of the neck ; then lay the instrument aside for some days, or better still, some weeks or months, and after that time, again immerse it in the same water at the same temperature and pressure, and with the same weight ; the instrument will now sink lower than before, in consequence of its diminished bulk from gradual contraction of the glass.

It was found that, although the effect was greatest after the glass had been rendered soft by heat, yet that it occurred also when the elevation of temperature had not extended nearly to the softening of the glass, and indeed more or less upon every rise of temperature. We have referred to an illustration of this at p. 160 of our last Number. Hence two kinds of irregularity in thermometers arise from the same cause. The one is manifested soon after the formation of the instrument, increases to a certain degree, and then remains stationary : this may be rectified by elevating the scale of the instrument the required quantity. The other takes place at every change of temperature ; it is small and scarcely perceptible, with small changes of temperature, but by considerable changes becomes very evident and important.

Singular consequences sometimes result from the influence of these changes. If two liquids be taken of different temperatures, a greater difference will be found between them, by trying the hot fluid, and then the cold fluid by the same thermometer, than what will appear to exist by trying the cold fluid first. Again, if a new thermometer be graduated by an old one preserved as a standard, although it may be made to agree with it, yet, after a while, the two will not accord ; and if two old thermometers be taken that do agree, and the one be heated whilst the other remains unused, they will no longer indicate the same temperatures.

The reason now becomes evident, why alcohol thermometers are so much less affected in this manner, than those filled with mercury. Alcohol expands several times more than mercury, so that an instrument constructed with it having a tube of the same diameter, and degrees of the same size, will require a bulb several times less than if mercury had been used. Hence, as the elevation is in proportion to the capacity of the bulb, independent of the liquid it contains, the alcohol thermometer will exhibit a much smaller effect than the mercurial instrument.

8. *Variation of Thermometers.*—MM. A. de la Rive and F. Marcet, have also investigated the elevation of the mercury in thermometers, which is due to the cause pointed out by Mr. Flaugergues, (xiv. 441,) namely, the continued pressure of the air on its external surface: and by opening the top of the thermometer; by submitting the instrument to condensed or rare atmospheres; and by comparison with thermometers otherwise constructed, have abundantly proved the effect due to this power. These philosophers had occasion also to remark some curious effects due to the absorption and evolution of heat, by the expansion and condensation of gases, which, however, we cannot at this time further attend to, than by copying the conclusions at the end of the memoir.

1. That atmospheric pressure exerts an influence on the bulk of thermometer bulbs. 2. That in experiments, where this effect may influence the results, it is better to use thermometers open at the top. 3. That certainly cold is produced in making a vacuum by the air pump, but in smaller quantity than was supposed*. 4. That when gases enter an exhausted vessel, there is at first a production of cold, and then of heat. 5. That various modifications may render the cold produced at the moment of the entrance of air into a vacuum, more intense.—*Bib. Univ.* xxii. 265.

9. *On Variations of Barometers and Thermometers.*—Sig. Belani has undertaken a series of experiments, to determine whether the air or vapour, the last portions of which are found to remain so obstinately in barometers and thermometers, is introduced with the mercury, or is a portion of that which originally occupied the tube before the introduction of the metal. The conclusion he comes to is, that it is always a portion of that which previously adhered to the glass, and that mercury is utterly incapable of absorbing either air or moisture. The extraordinary way in which air and water is held at it were in a film over glass, is insisted upon, and reference made to many authors in proof of it. The following, however, are more interesting, as being some of the facts he advances to prove that the mercury never contains either of these substances. Fill a barometer tube and boil it very carefully; then prepare a kind of funnel made of a small capillary tube, which will reach through the mercury in the barometer tube to the closed end, and is enlarged at top; let it be recently made, so as to be dry, and introduce it into the barometer tube; prepare some mercury by agitating it in a bottle with water and air, then drying its surface with bibulous paper, and afterwards passing it through paper cones three or four times into dry vessels; pour a little of this

* It has been stated, that when one of M. Breguet's metallic thermometers has been used, the diminution of temperature has amounted to 50°.—Ed.

mercury into the funnel tube, and with a horse-hair or fine wire remove the air, so that the column may be continuous; then pour in so much of this prepared mercury as will fully displace the mercury that was boiled in the tube; afterwards remove the funnel tube, and put the barometer to its proper use. It will be found to stand exactly at the same height as before in the same circumstances; and if the mercury be now boiled in the tube none of those bubbles will appear which arose on the first boiling; care being taken throughout, that the inner surface of the tube has not been exposed to the air.

Perhaps an easier mode of making the same experiment is to make the barometer terminate at top in a bulb, which will hold more mercury than is required to fill the tube: then when it is boiled it need only be placed upright in a basin of common mercury, and when inclined the mercury will enter and replace that which was boiled in the instrument; the results will be as above.

An experiment proving the same thing may be made still more easily thus: fill a mercurial thermometer and boil it well; then heat it till nearly all the mercury is expelled, but preserve its open extremity under common mercury: the latter metal will enter as the instrument cools, and behave in every respect as the well-boiled mercury did.—*Giornale di Fisica*, vi. 20.

10. *Maximum Density of Water*.—The maximum density of water is a point which, though frequently spoken of and sought after, has never been accurately ascertained. Mr. J. Crichton, of Glasgow, who has lately been engaged in determining the specific gravity of certain fluids by means of adjusted balls of glass, was so satisfied with the simplicity and accuracy of the method, that he determined to apply it to the investigation of the point above mentioned, and after much careful experiment has fixed it with apparently great accuracy at 42.3° F.

In a first experiment with these balls, one, which was just poised in water at 33° , had the same property near 51° ; this gave 42° for the point of greatest density, supposing the expansion equal for equal differences of temperature above and below the maximum density.

Many precautions are required in these kind of experiments: whilst cooling the water it should be kept as still as possible, agitation charging it with air; the presence of air-bubbles should be very carefully attended to, for when one happens to adhere to the ball, the experiment is vitiated. A uniform temperature should be attended to in every part of the mass of water, and the absence of currents ascertained. The delicacy of the ball itself may be imagined, when it is understood that the removal of the 6000th part of a grain, or as little as could possibly be ground off, has been too much. At first spherical balls were used, but afterwards they were made in the form of

parabolic spindles, sharp at the ends, of about an inch in length and $\frac{3}{10}$ in diameter. In order to ensure perpendicularity of the axes, before such a ball was hermetically sealed, a small globule of mercury was introduced, which effectually answered the purpose.

The mode of observation was as follows:—A jar with distilled water, thermometers and a bulb being arranged, the temperature being so low that the ball remained at the bottom of the water, was carefully watched with a large lens until the ball quitted the bottom, and at this moment the thermometers were noted. When the ball had risen a little, a small rod was cautiously let down, and, without agitating the water, gently made to touch the ball; it descended, but instantly rose: this is a very delicate part of the experiment, and if overdone loses its effect. It was repeated frequently, and the ball re-ascended each time with accelerated velocity. The thermometer indicating an increasing temperature, the ball finally became stationary at the surface; from time to time it was touched as before, but, as the temperature rose, the tendency of the ball to ascend, judging by the velocity with which it did so, each time diminished. Its upper extremity, by degrees seemed to press more feebly on the surface of the water, till at last a fine thread of separation became visible. The degree by the thermometers was again marked, and, as they continued slowly to rise, the ball gradually fell to the bottom of the jar. The intermediate point, between the two points noted, was then ascertained, and considered as the point of maximum density of the water. It appeared, from all the experiments, to be a little above 42° ; and, from one experiment, as before mentioned, to be 42.3° .—*Ann. Phil. N.S. v.*

11. *Tenacity of Iron Wire.*—At page 136, an account is given of an economical wire suspension-bridge erected at Annonay, by M. Seguin. It was expected that the difference of temperature at different seasons would influence the strength of this and similar bridges, and render it weaker at one time than another. M. Dufour has, therefore, undertaken some experiments, with a view of ascertaining any change in tenacity dependent upon such alteration of temperature. Some iron wire was procured, $\frac{1}{30}$ of an inch in diameter, and the weight required to break it ascertained from the mean of several experiments. A portion was then passed through a hollow vessel, filled with a frigorific mixture, which lowered the temperature to -8° F. In three experiments, in which wires, thus circumstanced, were broken by weights applied to them, the separation took place out of the vessel, and the weight required was the same as before. The vessel was then filled with boiling water, and the wire passing through it tried as before. It broke once in the vessel, and once out of the vessel, the latter by the smaller weight.

Finally, two vessels were then disposed on the wire, one containing the frigorific mixture, the other boiling water; the wire gave way between them, requiring the same weight as before.

It may thus be considered as demonstrated, that between the limits of temperature indicated *i. e.*, 212° and -8° F.; change of temperature has no influence on the tenacity of iron wire. —*Bib. Univ.*, xxii. 220.

12. *Electro-Magnetism. New Experiments by M. Seebeck on Electro-Magnetic Action.*—This gentleman, member of the academy of Berlin, has discovered that an electrical circuit can be established in metals, without the interposition of any liquid. The electrical current is established in this circuit by disturbing the equilibrium of temperature. The apparatus for exhibiting this action is very simple. It may be formed of two arcs of different metals; for example, copper and bismuth soldered together at the two extremities, so that together they make a circle; it is not even necessary that the metallic pieces should have the form of an arc, or that their union have that of a circle; it is enough if the two metals form together a circuit; that is, a continuous ring of any figure. To establish the current, we heat the ring at one of the two places where the two metals are in contact. If the circuit be composed of copper and bismuth the positive electricity will assume; in the part which is not heated, the direction of the copper towards the bismuth; but if the circuit be composed of copper and antimony, the direction of the current, in the part not heated, will be from the antimony towards the copper. These currents can be discovered only by the magnetic needle, on which they exercise a very perceptible influence. Henceforth we must distinguish this new class of electric circuits by a significant denomination; as such, the expression *thermo-electric circuits*, or perhaps *thermoelectric*, are proposed. We can, at the same time, distinguish the galvanic circuit by the name *hydro-electric*.—See xiv. 42.

13. *On the Oscillations of Sonorous Chords.*—In a science of such universal interest as music, which is the object of discussion, not only of the musician, but of the mathematician and the natural philosopher, it is remarkable what a discordance of opinion there exists with regard to those sounds called harmonics, and even with regard to the oscillations of sonorous chords. The following interesting theorem removes all obscurity from these subjects.

If any two sonorous chords, A and B, be so placed, as that the oscillations of one shall cause the air to act upon the other, as in all stringed musical instruments, and if A oscillates, m times, while B oscillates n times, m and n , being any whole numbers prime to each other; then, if either of these chords, as A, is put in motion, the action of the air will divide B into m equal

parts, each of which will oscillate n times, while A oscillates only once.

This theorem is the base of the theory of harmonics. It was deduced from a property demonstrated by Lagrange, in Sect. 6. *Mec. Analytique*, that a vibrating cord is susceptible of being divided into any number of equal parts, each of which would vibrate as if isolated. It affords a refutation of (what geometers seemed not absolutely to doubt) the assertion of Rameau, that every fundamental note in music is accompanied with its octave, twelfth, and seventeenth. It proves that, whether a sonorous homogeneous chord of uniform solidity has one, two, or three species of vibrations, these oscillations being necessarily performed in equal times, it cannot produce but one single note at a time. It is remarkable, that while the illustrious geometer just named had the proof of the fallacy of the received theory of harmonics before him, he was framing an hypothesis to account for its truth.

ii. CHEMICAL SCIENCE.

1. *A new Fluid discovered in Minerals.*—A new fluid, of a very singular nature, has been recently discovered by Dr. Brewster, in the cavities of minerals. It possesses the remarkable property of expanding about thirty times more than water; and, by the heat of the hand, or between 75° and 83° , it always expands so as to fill the cavity which contains it. The vacuity which is thus filled up is of course a perfect vacuum, and, at a temperature below that now mentioned, the new fluid contracts, and the vacuity re-appears, frequently with a rapid effervescence. These phenomena take place instantaneously in several hundred cavities, seen at the same time. The new fluid is also remarkable for its extreme volubility, adhering very slightly to the sides of the cavities, and is likewise distinguished by its optical properties; it exists, however, in quantities too small to be susceptible of chemical analysis. This new fluid is almost always accompanied with another fluid like water, with which it refuses to mix, and which does not perceptibly expand at the above-mentioned temperature. In a specimen of cymophane, or chrysoberyl, Dr. Brewster has discovered a stratum of these cavities, in which he has reckoned, in the space of $\frac{1}{7}$ of an inch square, 30,000 cavities, each containing this new fluid, a portion of the fluid like water, and a vacuity besides. All these vacuities simultaneously disappear at a temperature of 83° .

If such a fluid could be obtained in quantities, its utility in the construction of thermometers and levels would be incalculable. There are many cavities in crystals, such as those opened by Sir Humphry Davy, which contain only water, and which, of course, never exhibit any of the properties above described.

An account of these results was read before the Royal Society of Edinburgh, on the 3d and 17th of March.—*Edin. Phil. Jour.* viii. 400.

[We have seen a most curious and satisfactory specimen of amethyst quartz, containing the fluid above described by Dr. Brewster, in the collection of Thomas Allan, Esq. of Edinburgh. It exhibits three distinct oblong cavities, which, when the crystal is very slightly warmed, are to all appearance empty, but, upon cooling it by immersion in water, or by holding it against any cold substance, a portion of liquid is immediately perceived in each of the cavities, which gradually disappears as the crystal becomes less cold. The appearances are such as one might expect would arise from very highly condensed carbonic acid contained in the bubbles, assuming alternately the liquid and gaseous form, by very slight elevations and depressions of temperature.—Ed.]

2. *Crystallized Deposit in the Essential Oil of Bitter Almonds.*

Mr. Hendrie has just put into my possession a considerable portion of white crystalline matter, which, he observes, always separates from the above oil, when it is kept for some time, partially exposed to air. The crystals are flattened rhombic prisms. When cleared of the adhering oil, they are transparent, somewhat acrid and gritty upon the tongue, fusible and volatile at a heat of about 300° —insoluble in water, but readily and abundantly soluble in ether and alcohol; the latter depositing a white powder, when mixed with water. They dissolve in solutions of ammonia, potassa, and soda, and are not decomposed when boiled with nitric acid. Their further properties I have not yet had an opportunity of examining, but the above shew that they are peculiar.—W. T. B.

3. *On a new Compound of Iodine. Iodide of Carbon?—*

I Signori Ferrari e Frisiani, whilst preparing the iodate and hydriodate of potassa, observed the production of a new compound of iodine. It may be obtained thus:—Heat an ounce of iodine, with a little water, on a sand-bath, and add to it, by degrees, about two ounces of potash; when the two salts above mentioned will be formed. In order to saturate the excess of alkali, pour in, by degrees, a tincture composed of one ounce of iodine to six ounces of alcohol, specific gravity .837. When the re-action of the tincture on the potash is finished, pour the hot liquor on a filter, and the liquid which passes through will, as it cools, deposit yellow crystals, of the substance; they should be carefully washed in cold water, to remove all the iodate and hydriodate of potash. Another method is, to take the alcoholic solution of the two salts, prepared as above, and distil it; and when the fluid which comes over ceases to be coloured, to change the receiver; the colourless liquor then obtained, upon cooling, deposits very pure crystals, of the sub-

stance in question. If the distillation be suspended from time to time, and the retort allowed to cool, beautiful crystals of the substance form in it. If strong alcohol be used in the above operations, and but little water, then, upon adding water to the filtered liquor, the substance is precipitated in abundance.

This substance is solid, of a lemon yellow colour, tastes like nitric ether, and has an odour like that of saffron. Its form is a compressed hexahedron (*esaedro schiacciato*). It is insoluble in water, alkalis, or acids, but soluble in alcohol and ether. It fuses and sublimes by a gentle heat, but at a higher temperature becomes discoloured, is decomposed, and evolves vapours of iodine, leaving behind a mere trace of carbon.—*Giornale di Fisica*, v. 241.

Il Sig. Taddei has more lately resumed the examination of this substance, particularly with regard to its composition. He recognises in it the same body as that discovered by M. Serullas, and which the latter chemist formed in various ways, as by the action of potash on an alcoholic solution of iodine; by the action of alloys of potassium and antimony on a similar solution; and by passing water and iodine in vapour over hot charcoal.

Taddei found the substance to act on mercury, copper, and silver, forming iodides of these metals. When raised to a high temperature it was decomposed, hence he endeavoured in this way to ascertain the presence of hydrogen in it. No gas could, however, be obtained from it, and the absence of hydrogen was considered as established. The presence of carbon was ascertained in the residuum after decomposition by its producing carbonic acid when burnt in oxygen, and by its converting sulphate of barytes into sulphuret, which, on treatment with an acid, gave sulphuretted hydrogen gas.

The next object was to ascertain the quantities of the two elements found in it. The iodine was estimated thus: a given weight was decomposed by heat in a long tube of glass, and the iodine washed out by alcohol; the solution was diluted with water, and sulphuretted hydrogen gas passed through it; when it was presumed that all the iodine had been converted into hydriodic acid, the sulphur thrown down was collected, weighed, and the quantity of iodine inferred by the theory of proportional quantities. The carbon was carefully collected, introduced into a porcelain tube, to one end of which was attached a bladder containing a portion of oxygen, whilst from the other a tube led to a mercurial apparatus; the tube was then heated, the charcoal burnt, and its quantity estimated from the quantity of carbonic acid gas produced. Nearly the same experiment was repeated on the original iodide of carbon, and the same quantity of carbonic acid gas obtained.

The results of these experiments give the proportion of the carbon to the iodine as 1 to 17 by weight, and M. Taddei concludes, therefore, that the substance is a protiodide of carbon.

It ought, however, to be noticed that M. Serullas considers the body as a triple compound of carbon, hydrogen, and iodine, analogous to the one described by Mr. Faraday, as do also I Sig. Frisiani and Ferrari, but they have given no precise experiments on the subject. A proportion of hydrogen would make so small a part of the weight of the substance as easily to escape notice, unless carefully looked for.—*Giornale di Fisica*, vi. 65.

An elaborate paper has also appeared on this subject, by M. Serullas, in the *Annales de Chimie*, xxii. 172; for a full account of which, see the *Foreign Science*, p. 297. By his analysis, it appears to be a triple compound, and not an iodide of carbon; and it is remarkable, that the composition he has given is as nearly as possible that of the compound, described and analyzed by Mr. Faraday.—See Vol. xiii. p. 429.

4. *Triple Compounds of Chlorine*.—M. Despretz has read a memoir on this subject to the Academy of Sciences; the liquids which principally engaged his attention were those produced by the action of chlorine on olefiant gas, alcohol, and ether. The first of these liquids has been considered as a compound of equal volumes of chlorine and olefiant gas, a result which was confirmed by direct experiment. As to the liquid formed by the reaction of chlorine on alcohol, it proved to be a compound of one volume of chlorine and two of olefiant gas. The two liquids obtained by chlorine from ether have not been so accurately examined; but one of them is considered as a new compound of chlorine and olefiant gas.

In examining the action of olefiant gas on the chlorides of sulphur and iodine, M. Despretz observed some remarkable results. The chloride of iodine gave two substances, the one a colourless liquid with an agreeable taste and smell, and crystallizing in plates at 32°; the other resulting from the action of a greater quantity of olefiant gas, was white, solid, and crystalline.

With chloride of sulphur, a viscid liquid was produced, more fixed than water, of a disagreeable odour, and difficultly combustible.—*Ann. de Chim.* xxi. 437.

5. *Action of Chlorine on Muriate of Iron, &c.*—M. Van Mons saturated a concentrated solution of proto-muriate of iron with chlorine; it became of a deep brown colour, did not give out the odour of chlorine, tasted very astringent, and slightly acid, and sweet. After some time, golden-coloured crystals formed in the solution, and chlorine was developed in great abundance. These crystals liquefied in the air, and could not be again crystallized.

Gmelin, by passing chlorine through a solution of ferro-prussiate of potash, obtained a salt in fine rose-coloured crystals. It was composed of two proportions of prussic acid, one proportion of potash, and half a proportion of protoxide of iron.—*Giornale di Fisica*.

6. *On the Preparation of Potassium and Sodium.*—It is well known to chemists, that the frequent failures in the preparation of the alkaline metals arise from the high heat required in the operation, which frequently fusing or cracking the lute on the barrel, exposes it to the air and fire, when it is soon burnt, and the product either partly or entirely lost. The object of M. Brunner, who is the author of the following experiments, was to perform the operation at a comparatively low temperature, which he has been enabled to effect by the following apparatus.

The retort is a spheroidal iron bottle, about half an inch in thickness, and capable of holding about a pint of water; a gun-barrel bent into this form () screws into it at the shorter end. When the retort is charged and luted, it is placed in a furnace, so that the longer part of the bent gun-barrel may pass out at the bottom, or in front, in a direction nearly perpendicular, the bent part itself remaining in the furnace; and that it may be protected from the fire, it is wound round with iron wire. The receiver is a cylindrical copper vessel, with an opening at the top to receive the end of the gun-barrel, and a tube passing from the side to convey away the gas produced in the operation. It is placed, when in use, in water or ice.

The following is an instance of its use: the retort was cleaned, dried, and heated, and then four ounces of fused caustic potash introduced in small portions alternately with six ounces of iron turnings broken in a mortar, mixed with one ounce of pulverized charcoal. The whole was stirred together, and covered with two ounces of iron turnings. The retort being luted, the barrel adapted, the whole placed in the furnace, and a glass tube attached to the end of the barrel, that the progress of the operation might be watched, the fire was lighted, and the heat gradually raised: in ten minutes an inflammable gas came over, which in ten minutes more burnt with a violet flame, producing much fume; in ten minutes more the green vapours of potassium appeared. The receiver containing naphtha was now adapted, so that the end of the barrel should dip into the fluid; the liberation of gas was very rapid, and it frequently inflamed spontaneously, burning with a white violet flame. In about twenty-five minutes from the application of the receiver, the gas diminished in quantity, and soon entirely ceased coming over; the receiver was separated, and found to contain 150 grains of potassium.

Eight ounces of fused sub-carbonate of potash, 6 ounces of iron filing, and 2 ounces of charcoal treated in the same way, gave 140 grains of potassium.

To ascertain the effect of the charcoal in these experiments, 3 ounces were mixed with 6 ounces of fused sub-carbonate of

potash. The result was much inflammable gas, a pyrophorus powder, and 180 grains of potassium.

When iron alone was used, not a particle of potassium could be obtained at the heat, to which only this apparatus could be raised.

Crude tartar was then used ; it was introduced into the apparatus and heated, till the acid was decomposed ; then the tube removed, cleaned, and again attached, and the heat raised as in the ordinary process. The mean of many experiments gave nearly 300 grains of potassium from 24 ounces of crude tartar. Not more than an ounce of alkali was found at any one time in the retort after the operation. When the tartar was previously mixed with $\frac{1}{12}$ of charcoal, the product was greater.

In the preparation of sodium, caustic soda, and the subcarbonate of soda were both used at different times, and with the same success as attended the former experiments.

M. Brunner remarks, that a large quantity of the metal contained in the alkali, always disappeared in these experiments ; and concludes, that it was carried off in vapour. He endeavoured to condense it, but without success. He states, in conclusion, that the apparatus is cheap and durable, having served for as many as thirty operations : that the process is easy and agreeable compared to that by iron at the high temperature : and that, as the vegetable salts with a little additional charcoal, are the best sources of the metals, so the process becomes very economical.—*Bib. Univ.* xxii. 36.

7. *Hydrocyanic acid, Preparation of.*—M. Pessina, of Milan, prepares hydrocyanic acid in the following manner, which is said to be much more economical than any other process known. Eighteen parts of triple prussiate of potash and iron are powdered very fine, and carefully introduced into the bulb of a small tubulated glass retort, a very small tubulated balloon is then attached to the retort ; it is furnished with a conducting tube which dips into the first flask, containing a little distilled water. The rest of the apparatus is contrived so as to prevent absorption. A cold mixture of nine parts of oil of vitriol, and twelve parts of water, is then poured into the retort, the retort closed and the whole left for 12 hours, the balloon being surrounded with ice, and the neck of the retort constantly cooled with wet cloths.—The materials are then to be heated a little, and continued so until the stræ, which are observed in the neck of the retort become more rare, and, until a blue substance rises, which appears as if it would pass into the receiver. The heat is then to be discontinued, the apparatus allowed to cool, and the contents of the receiver preserved in a proper vessel. The hydrocyanic acid, thus obtained, is perfectly pure, and of a specific gravity of 0.898 or 0.9. Its quantity, in relation to the

quantity of substances used, is not stated.—*Giornale di Fisica*, v. 285.

8. *Production of Cyanurets*.—Cyanogen, according to M. Brunner, is formed whenever a potash salt with a vegetable acid is burnt with nitre:—ten parts of cream of tartar with one of nitre, or two parts of acetate of potash with one of nitre, when burnt, leave a product containing a notable proportion of cyanogen. It has been shewn by M. Pagenstecher, that when eight parts of nitre and five parts of tartar are burnt together, ammonia is formed.

9. *Iodide of Nitrogen*.—M. Serullas describes the following process, for the preparation of this detonating compound. Form a sub-chloride of iodine, to which, add ammonia in excess; muriatic acid is formed, and the iodine is almost entirely combined with the nitrogen, scarcely any hydriodate of ammonia being formed. The solid substance produced, is to be thrown on a filter, washed, and dried carefully. In the usual method, scarcely a fourth part of the iodine enters into combination with the nitrogen.—*Ann. de Chim.* xxii. 186.

10. *Thenard's Blue*.—This blue is considered by M. Thenard, as a combination of alumine and oxide of cobalt, and is prepared in the following manner. Nitrate of cobalt prepared in the usual way, from the ore of cobalt by torrefaction, digestion in nitric acid, evaporation, and solution, is to be precipitated by a solution of sub-phosphate of soda. The insoluble phosphate of cobalt is to be well washed, and then collected together, whilst in the gelatinous state, and mixed in the most perfect manner possible, with eight times as much hydrate of alumina in the same state. The mixture is spread on smooth plates, dried in a stove, when hard and brittle reduced to powder, and heated in a covered earthen crucible. After half an hour's ignition, it should be taken from the fire, and should then be of the colour required. The operation is always successful if the precautions be attended to, and it is particularly important, that the gelatinous alumina shall have been precipitated by an excess of ammonia, and has been well washed with very pure water, until quite free from impurity.

The arseniate of cobalt may be employed in place of the phosphate, but it requires twice as much alumina to be mixed with it.—*Dict. Tech.*—*Tech. Rep.* iii. 340.

11. *On a Per-sulphate of Iron and Ammonia*.—Dr. Forchhammer having prepared a solution of gold by means of nitric acid and muriate of ammonia, and precipitated the gold by proto-sulphate of iron, the clear solution was concentrated to

the consistence of syrup, and suffered to remain for a month ; when beautiful octoëdral crystals, of a wine-yellow colour, were formed on the sides of the vessel. On examination, it was found to contain ammonia, and to be an alum, in which peroxide of iron supplied the place of alumina.

The salt dissolves in three parts of water at 60°, and, by repeated crystallization, may be obtained, perfectly colourless. On careful analysis, 100 parts appeared to be composed of

Per-sulphate of iron . .	41.807
Sulphate of ammonia . .	12.366
Sulphate of alumina . .	0.870
Water	

On further examination, Dr. Forchhammer found the sulphate of alumina to be accidental, and neglecting it, ascertained the composition to be,

Per-sulphate of iron . .	41.95
Sulphate of ammonia . .	12.11
Water	45.94

He considers it as identical with the salt formerly described by Mr. Cooper, as a bi-persulphate of iron.

As the results deducible from this analysis seemed to agree so well with M. Mitscherlich's idea, that per-oxide of iron and alumina are isomorphous, and afforded additional proof of the correctness of his views, Dr. Forchhammer was more earnest to ascertain the exact quantity of water, and to compare it with ammonia alum ; which salt gave, on analysis,

Sulphuric acid	35.90
Alumina	11.50
Ammonia	3.86
Water and loss	48.74

This alum is, therefore, composed of three atoms of sulphate of alumina, one atom of sulphate of ammonia, and 24 atoms of water—and the triple salt above described, of three atoms of per-sulphate of iron, one atom of sulphate of ammonia, and 24 atoms of water.—*Ann. Phil.* v.

12. *Test for Proto-salts of Iron.*—Professor Ficinus, of Dresden, strongly recommends a solution of muriate of gold, as the most delicate of all tests for the presence of protoxide of iron in solution, surpassing considerably even the gall nut. It requires the presence of carbonate of soda, which, in some analyses, may perhaps interfere with its use. A grain of green vitriol, with an equal weight of soda, dissolved in four pints of water, produces, with a drop of solution of muriate of gold, a strong precipitate, which gradually assumes a purple colour. Without the soda, the effect did not appear in less than three

days. M. Ficinus thinks the process may be improved even to the determination of the quantity of protoxide of iron present. *Bib. Univ.*

13. *Test for Barytes and Strontia.*—At p. 189, vol. x. is a process to distinguish between barytes and strontian; the repetition of it in most of the chemical journals is a proof that such a test was wanted. Mr. Smithson recommends the following as better. Put a particle of the soluble salt formed, into a drop of muriatic acid, on a plate of glass, and let the solution crystallize spontaneously. The crystals of chloride of barium, in rectangular eight-sided plates, are immediately distinguishable from the fibrous crystals of chloride of strontium.

As a test between the sulphates of the two earths, Mr. Smithson directs, that the mineral, in fine powder, be blended with chloride of barium, and the mixture fused. The mass is to be put into spirit of wine, whose flame is coloured red, if the mineral was sulphate of strontium. The red colour of the flame is more apparent when the spirit is made to boil, while burning, by holding the platina spoon containing it over the lamp.—*Ann. Phil. N. S.* v. 359.

14. *Action of Phosphorus on Water.*—Mr. Phillips has ascertained, by direct experiments, that when phosphorus is preserved in water, there is a mutual action attended with decomposition of the fluid. The oxygen of the water forms, at first, oxide of phosphorus, and, eventually, phosphorous or phosphoric acid; whilst the hydrogen, combining with phosphorus also, forms phosphuretted hydrogen. These changes take place much more rapidly when light has access, than in the dark.—*Ann. Phil. N. S.*

15. *Fixedness of Sulphuric Acid.*—M. Bellani placed a thin plate of zinc in the upper part of a closed bottle, at the bottom of which was some concentrated sulphuric acid. No action had taken place at the end of two years, the zinc remaining as bright as at first. This fact is adduced in illustration of the fixedness of sulphuric acid at common temperatures.—*Giornale di Fisica*, v. 197.

16. *Effect of a Vacuum on Alkaline Carbonates*, by Dobereiner.—I have found that these carbonates, (bi-carbonates,) when dissolved in the smallest quantity of water possible, or when covered with water, and left for half an hour in a vacuum, lose one-fourth of their acid. If, after being thus treated, they are put in a graduated tube over mercury, and acted on by a saturated solution of proto-sulphate of manganese, only about half the quantity of carbonic acid is set free, which may be

obtained, if afterwards a sufficient quantity of acid be added, to decompose the carbonate of manganese formed. These alkaline carbonates are modified, therefore, like the radiated natron of Tripoli, which I have ascertained to be composed as follows:

Bi-carbonate of soda, 1 = 30 soda + 41.4 carbonic acid
 Carbonate of soda . 1 = 30 — + 20.7 carbonic acid
 Water 4

The same compound, is formed, if one part of bi-carbonate of soda, and four of water, be boiled until gas ceases to be liberated. I have not as yet been able to obtain the radiated crystalline structure.—*Bib. Univ.* xxii. 123*.

17. *Formation of Calcareous Spar.*—Mr. Haig, on pouring out the contents of a bottle of Saratoga water, which had stood several years in a cellar, found the bottom to contain well-defined crystals of calcareous spar, which, on being split, exhibited the usual appearance of that substance.—*Edin. Journ.*

18. *Action of Animal Charcoal on Lime.*—Animal charcoal is not only capable of separating colouring matter and extractive from solution, but will even remove lime from them. This may be proved according to Payen, by boiling 100 parts of lime-water for a few seconds with 10 parts of animal charcoal, and then testing the clear liquor by oxalate of ammonia; not a particle of lime will be found in it. Vegetable charcoal, or lamp-black, do not produce this effect.

19. *Bizio on Virgin Wax.*—Sig. Bizio has separated wax into two substances: it is to be boiled in alcohol until the whole is dissolved, and the solution then allowed to cool, and its temperature lowered 10° or 20° below the freezing point; a large quantity of white matter then separates, which is the wax; and there remain in solution the colouring principle, and an acid substance, which strongly reddens tincture of turnsole. The solid precipitate being separated by a filter, the fluid was evaporated, and left a fatty substance, of the consistence of butter, of a yellow colour, having the odour of honey, and melting at a temperature of 116° F.—*Giornale di Fisica*, v. 374.

20. *Separation of Elaine from Oils.*—This process is due to M. Pictet, and is founded on the property possessed by stearine, of being saponified by cold strong alkaline solutions, which does not belong to elaine. In order to separate these two substances, a concentrated solution of caustic soda is poured on to oil, and agitated with it; it is then slightly

* See Mr. Phillips on Alkaline Carbonates.

heated, to separate the elaine from the soap of stearine; is passed through a cloth, and, finally, the elaine separated from the excess of alkaline solution, by decantation. This process is successful with all oils, except those which are rancid, or have been altered by fire. The elaine is perfectly identical with that obtained by the processes of MM. Chevreul and Braconnot. *Ann. de Chim.* xxii.

21. *On the Clarification of Wine.*—There is sold in France, and at a very high price, relative to its value, a reddish-brown powder for clarifying wines. It is prescribed, in employing it, to put into a vessel the quantity of water or wine, which is usually mixed with whites of eggs, to sprinkle gently the powder on the liquid; and, when it is well mingled, to pour the mixture into a cask, finishing the operation in the usual way. M. Gay-Lussac says, that the clarifying-powder is nothing but dried blood, and that he has prepared some with particular care in the desiccation, which was even superior to that on sale. The whites of two eggs contain as much albumen (which is the sole clarifying principle) as the dose of powder prescribed for the clarification of a cask of two hundred litres. It will be found more beneficial to make use of the white of egg,—both in reference to economy, and to that of the bad odour of glue possessed by the solution of dried blood, which might affect the flavour of fine wines. M. Gay-Lussac has prepared a powder, with the whites of eggs dried, which has not the same inconveniences as blood, which mixes easily with water, and clarifies very well.

III. NATURAL HISTORY.

1. *Blumenbach on Irritability of the Tongue.*—I had the tongue of a four year old ox which had been killed in the common way, by opening the large vessels of the neck, cut out in my presence while yet warm, and at the same time the heart, in order that I might compare the oscillatory motion of this organ, which is by far the most irritable that we are acquainted with, with the motion of the tongue; and, when I excited both viscera at the same time, by the same mechanical stimuli, namely, incisions with a knife and pricks of a needle, the divided tongue appeared to all the bystanders to survive the heart more than seven minutes, and to retain the oscillation of its fibres altogether for a quarter of an hour; and so vivid were the movements when I cut across the fore part of the tongue, that the butcher's wife compared them to those of an eel in similar condition, quite in the way that Ovid has compared them to the motions of the tail of a mutilated snake.—*Edin. Phil. Jour.* VIII. 263.

2. *Sensation experienced at great Altitudes.*—Capt. Hodgson in his journey to the head of the Ganges, which he found in the midst of eternal snows, says, whilst speaking of the sensations felt at great altitudes, “We experienced considerable difficulty in breathing, and that peculiar sensation which is always felt at great elevations where there is any sort of herbage, though I never experienced the like on naked snowbeds, even when higher. Mountaineers, who know nothing of the thinness of the air, attribute the faintness to the exhalations from noxious plants; and I believe they are right, for a sickening effluvium was given out by them here, as well as on the heights under the snowy peaks which I passed over last year above the Setlej, though on the highest snow the faintness was not complained of, but only an inability to go far without stopping to take breath.—*Edin. Phil. Jour.*

3. *On the Action of Nitrogen in the Process of Respiration.*—Dr. Edwards, who is well known as an intelligent physiologist, concludes, from different experiments, and from the circumstance of the opposite results which they give, some indicating a diminution of the nitrogen of the air, others an increase of it, during respiration, that this gas is absorbed into the circulation, and afterwards discharged from it; and that each of these actions is regulated by the constitution, habit, and circumstances of the individual, and by the influences to which he may be subjected, the absorption being to a small extent, while the exhalation is considerable, and *vice versâ*.—*Journ. de Phys., January, 1823.*

4. *Diabetes.*—M. Van Mons says, “I have met with a very singular diabetic urine; it gives no indication of ammonia with any chemical re-agent, nor does it possess the odour of urine; but this odour is strongly developed, and that also of ammonia, at the same time accompanied by a brisk effervescence, if a few drops of sulphuric acid be added to it. These products are supposed to arise from the action of the acid on the urea.—*Giornale de Fisica.*

5. *Toad in a Solid Rock.*—The workmen engaged in blasting rock from the bed of the Erie canal at Lockport in Niagara county, lately discovered, in a small cavity in the rock, a toad in the torpid state, which, on exposure to the air, instantly revived, but died a few minutes afterwards. The cavity was only large enough to contain the body without allowing room for motion. No communication existed with the atmosphere, the nearest approach to the surface was six inches through solid stone. It is not mentioned whether the rock was sandstone or limestone, but from the prevalence of limestone on the sur-

face of the contiguous country, it may be presumed to have been the latter. The country is wholly of secondary formation. Of the causes which enable animals of this class, which have been suddenly enveloped in strata of earth, or otherwise shut out from the air, without injury to the animal organ, to resume, for a limited period, the functions of life on being restored to the atmosphere, no explanation need here be given, as the occurrence is a very common one, and is, perhaps, always more or less the result of galvanic action.—*Silliman's Journal*.

6. *On the Sensitive Plant, (Mimosa Pudica). By M. Dutrochet.*—It is known that the movements of the leaves of this plant have their origin in certain enlargements situated at the articulation of the leaflets with the petiole, and of the petiole with the stem. Those only situated in the last articulation are of sufficient size to be submitted to experiment. If, by a longitudinal section, the lower half of this swelling be removed, the petiole will remain depressed, having lost the power of elevating itself; if the superior half be removed the petiole remains constantly elevated, having lost the power of depressing itself. These experiments prove that the motions of the petiole depend on the alternate turgescence of the upper and lower half of the enlargement situated at the point of articulation, and that contractibility is not the principle of these motions.

If one part of the plant be irritated, the others soon bear witness, by the successive falling of their leaves, that they have successively felt the irritation. Thus, if a leaflet be burnt slightly by a lens, the interior movement which is produced is propagated successively to the other leaflets of the leaf, and thence to the other leaves on the same stalk. M. Dutrochet found, 1. That this interior movement is transmitted equally well, either ascending or descending. 2. That it is also equally well transmitted, although a ring of bark be removed. 3. That it is transmitted also, even though the bark and the pith be removed, so that nothing remains to communicate between the two parts of the skin, except the woody fibres and vessels. 4. That it is transmitted also when the two parts communicate only by a shred of bark. 5. That it is transmitted when the communication is completed by the pith only. 6. But that it is not transmitted when the communication only exists by the cortical parenchyma. It results from these experiments that the interior movement, produced by irritation, is propagated by the ligneous fibres and the vessels. The propagation is more rapid in the petioles than in the body of the stem: in the first it moves through from $\frac{3}{10}$ to $\frac{6}{10}$ of an inch in a second, in the latter from $\frac{8}{100}$ to $\frac{12}{100}$ of an inch in the same time. External temperature does not appear to exert any

influence upon the rapidity of the movement, but very sensibly affects its extent.

Absence of light, during a certain time, completely destroys the irritability of the plant. The change takes place more rapidly when the temperature is elevated, than when low. The return of the sun's influence readily restores the plant to its irritable state. It appears, therefore, that it is by the action of light, that the vital properties of vegetables are supported, as it is by the action of oxygen, that those of animals are preserved; consequently, etiolation is to the former, what asphyxia is to the latter.—*Jour. de Phys.* xcv. 474.

7. *Vegetation in Atmospheres of different Densities.*—The following experiments have been made by Professor Dobereiner of Jena. Two glass vessels were procured, each of the capacity of 320 cubic inches, two portions of barley were sown in portions of the same earth, and moistened in the same degree, and then placed one in each vessel. The air was now exhausted in one, till reduced to the pressure of 14 inches of mercury, and condensed in the other, until the pressure equalled 56 inches. Germination took place in both nearly at the same time, and the leaflets appeared of the same green tint; but, at the end of 15 days, the following differences existed. The shoots in the rarefied air were 6 inches in length, and from 9 to 10 inches in the condensed air. The first were expanded and soft; the last rolled round the stem and solid. The first were wet on their surface, and especially towards the extremities; the last were nearly dry. "I am disposed," says M. Dobereiner "to believe, that the diminution in the size of plants, as they rise into higher regions on mountains, depends more on the diminution of pressure than of heat. The phenomena of drops of water on the leaves in the rarefied air, calls to my mind the relation of a young Englishman, who, whilst passing through Spanish America as a prisoner, remarked, that on the highest mountains of the country, the trees continually transpired a quantity of water, even in the driest weather; the water falling sometimes like rain."—*Bib. Univ.* xxii. 121.

8. *Fruit-Trees.*—The growth of weeds round fruit-trees recently transplanted does them much injury, and diminishes their fruit in size and quality. Sonnini in his *Bibliothèque Physico-économique* states, that to prevent this, the Germans spread on the ground, round the fresh transplanted trees, as far as their roots extend, the refuse stalks of flax after the fibrous part has been separated. This gives them surprising vigour. No weed will grow under flax refuse, and the earth remains fresh and loose. Old trees, treated in the same manner when languishing in an orchard, will recover and push out vigorous

shoots. In place of the flax-stalks the leaves which fall from trees in Autumn may be substituted, but they must be covered with waste twigs, or any thing else that will prevent the wind from blowing them away.—*Phil. Mag.*

9. *Mesotype from Mount Vesuvius.*—Il Conte Paoli has ascertained the existence of mesotype among the products of Mount Vesuvius. He describes the fibrous mesotype and the hyaline mesotype, and has no doubt of their being real volcanic products formed in the lava at the time of cooling.

10. *Native Sulphate of Iron and Alumina.*—This is a salt which has lately been found in abundance in the slate clay of the deserted coal-mines of Hurlet and Campsie, and results from the decomposition and mutual action of pyrites on the clay. It was given by Mr. Macintosh to Mr. Phillips, who describes it as existing in the state of soft, delicate, silky, colourless fibres, resembling asbestos in appearance. By exposure to moist air the iron becomes peroxidized. It dissolves in water, yielding on evaporation crystals of sulphate of iron, and a mother liquor of sulphate of alumina. Its solution with salts of potash or ammonia yields alum. The salt on analysis was found to be composed of

Sulphuric acid . . .	30.9 or 4 atoms . . .	=	160
Protoxide of iron . . .	20.7 . . . 3 . . .	=	108
Alumina	5.2 . . . 1 . . .	=	27
Water	43.2 . . . 25 . . .	=	225
	100		520

Ann. Phil.

11. *Bitumen in Minerals.*—In a curious paper upon the analysis of minerals, lately communicated to the Royal Society by the Right Hon. George Knox, he demonstrates the existence of bitumen in a great variety of mineral products where it has hitherto escaped observation, such as basalt, greenstone, serpentine, mica, &c.; and shows the necessity of attending to this volatile ingredient in all cases of analysis, where it has been generally suffered to escape observation from the loss by ignition having too commonly been ascribed to *water*. He recommends, with this view, that distillation, in a proper apparatus, should always precede the other steps of analysis, and that the nature of the volatile products, thus obtained, should be particularly examined.

12. *Italian Marble.*—The workmen employed in working the marble-quarry, discovered near Florence, proceed with activity; they have opened a way leading to Mount Altissimo, near Se-varezza. The first blocks were sent to Paris, the others are

reserved for Florence and Rome. These excavations will provide for Tuscany an important branch of industry and commerce.

13. *Bagne Lake and Glacier*.—A description was formerly given (v. 372 and vi. 166.) of the singular lake which had formed in the valley of Bagne, in consequence of the blocking up of the river Dranse by a glacier, and also of the immense destruction it occasioned by overthrowing its barrier, and escaping at once into the lands beneath it. Up to the year 1805, no glacier of this kind existed, but a large one on the precipices above continually sent down blocks and masses of snow and ice, which were removed by the waters of the rivers. It was the cold years succeeding 1805 that gave rise to the permanent formation of the lower glacier, for the masses of snow that fell into the river were so large that it had not the power to remove them, though it found a passage by filtration through them; and then succeeding winters hardened and consolidated the whole until it gave rise to the catastrophe already described.

The event which then took place, did not remove the whole of the lower glacier or barrier; on the contrary, scarcely a twentieth part was broken down, and the river remained forced from its old bed, and bordered on one side by the glacier, which accumulated so rapidly, that, at the end of 1819, the barrier to the passage of the river was almost as complete as before its breaking up by the weight of the lake.

It became, therefore, an important object to prevent a repetition of the former catastrophe, by the adoption of such means as would diminish, or, at least, prevent the increase of the barrier. Blasting by gunpowder was found inadmissible from the difficulty of firing the powder at considerable depths in the ice, and from the comparatively small masses removed by this means. After much consideration and many trials, a mode has been adopted and put in execution by M. Venetz, which promises the greatest success.

M. Venetz had remarked that the glacier could not support itself where the river was of a certain width, but fell into it, and was dissolved; whereas, where the river was comparatively narrow, the ice and snow formed a vault over it, and consequently tended to the preservation of any portion falling from the glacier above. Perceiving also the effect of the river in dissolving the parts it came in contact with, he formed and executed the design of bringing the streams of the neighbouring mountains by a canal to Mauvoisin, opposite the highest part of the glacier, where it touched that mountain. From hence it was conducted, by wooden troughs, on to the glacier in a direction parallel to the valley. The water was divided into two streams, one falling nearly on the one edge of the Dranse, and the other on the other; and having been warmed by the sun in its

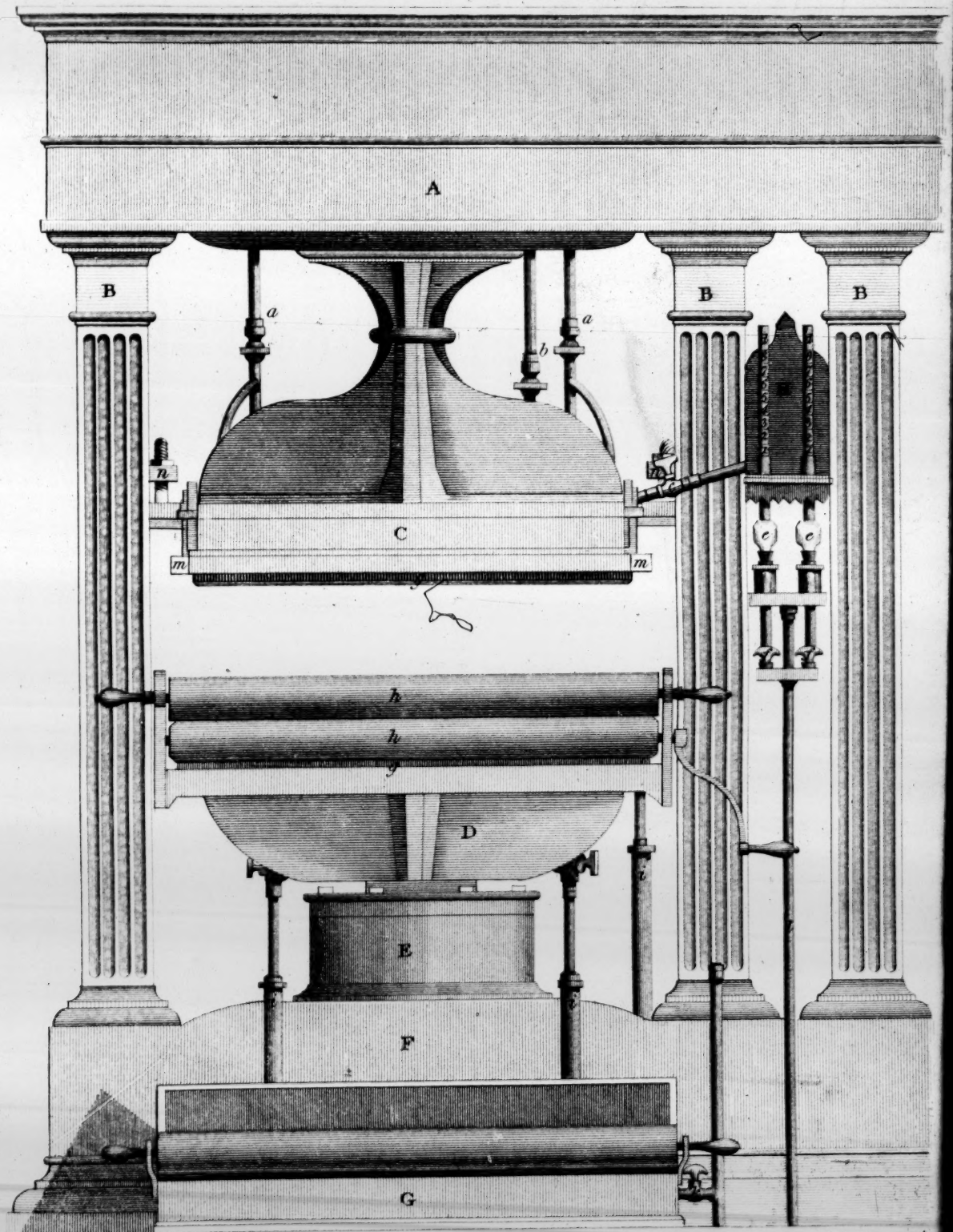
course, soon cut very deep channels in the ice. When they reached the river, the troughs were removed a few feet, and thus the streams produced the effect of a saw, which, dividing the ice, forced the portion between them to fall into the Dranse.

When the weather is fine, these streams, which are not more than four or five inches in diameter, act with extraordinary power, piercing a hole 200 feet deep and six feet in diameter in 24 hours. They are calculated to remove one hundred thousand cubical feet of ice from the barrier daily, and it is supposed that, if the weather is fine, the whole will be removed in three years.

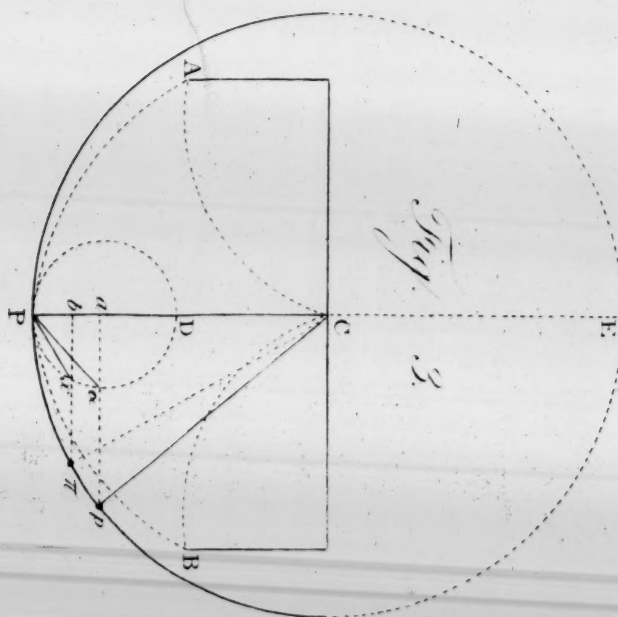
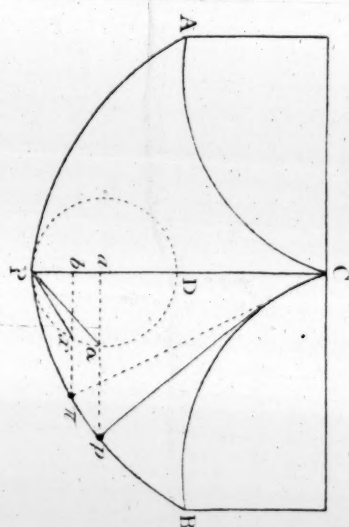
At the end of the season of 1822, the Dranse remained covered only for a length of 80 toises (of six feet), whereas at the commencement of the operation it was covered over a length of 225 toises. M. Venetz estimates the quantity of ice, removed in 1822, as between eleven and twelve millions of cubical feet.—*Bib. Univer.* xxii. 58.

14. *On the Theory of Falling Stars.*—M. Bellani, in a *mémoire* on the meteors called falling stars, supports the theory that they are formed by the combustion of trains of inflammable gases or vapours in the atmosphere. He thinks that these trains may exist in the higher regions without being dissipated, in consequence of the general and perfect tranquillity which may be considered as existing there. He endeavours to combat the difficulty which is generally urged to such a theory, of the diminished inflammability of any gaseous or vaporous mixture by expansion, by referring to the vapour of phosphorus, stating, “that phosphorus becomes luminous, or suffers a slow combustion, at a temperature so much the lower as the quantity of oxygen gas in a determinate space is rendered smaller, either by mixture with other gases, or by rarefaction;” and then ventures the conjecture, that there may be other substances, capable by natural operations of being reduced into the state of vapour or gas; and which, though at common temperature and pressure are not inflammable, may become so by being elevated in the atmosphere.—*Giornale di Fisica*, v. 195.

15. *Preservation of Anatomical Preparations.*—Dr. Macartney, of Dublin, employs for this purpose a solution of alum and nitre, which preserves the natural appearance of most of the parts of the body much better than spirit of wine, or any other liquid hitherto employed. In order to impregnate entirely anatomical preparations, the liquid ought to be renewed from time to time at first. The proportion of the two salts and the strength of the solution should vary according to circumstances. The solution possesses such an antiseptic power that it destroys completely, in a few days, the fœtor of the most putrid animal substances.—*Ann. de Chim.*, xxi. 223.



J. Basire sculp.





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LONDON:
PRINTED BY WILLIAM CLOWES,
Northumberland-court.

